FLUKE

# Manual Supplement

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|---|---|---|---|
| Manual Title: | 732B/734A | Supplement Issue: | 3 |
| Part Number: | 869321 | Issue Date: | 1/96 |
| Print Date: | March 1992 | Page Count | 4 |
| Revision/Date: | 2, 4/94 | | |

This supplement contains information necessary to ensure the accuracy of the above manual.

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**CHANGE #1 - 49453**

Rev. -F, A5 Power Supply PCA (732B-7605)

On pages 6-17 and 6-18, Table 6-4, delete row C529,530 and change the following:

| | |
|---|---|
| CHANGE: | C509,505,506,509,513,517,519,520,522,523,528,537-539/CAP,POLYES,0.22UF, +-10%, 50V,706028/68919/MKS1224K50B/14 |
| TO: | C509,505,506,509,513,**517,520**,522,523,528,537-539/ CAP,POLYES,0.22UF, +-10%, 50V,706028/68919/MKS1224K50B/**13** |
| CHANGE: | C518,540/CAP,TA,22UF,+-20%,25V,845149/53298/199D226X0025DG2/2 |
| TO: | C518,**519,C529,C530**,540/CAP,TA,22UF,+-20%,25V,845149/53298/199D226X0025DG2/**5** |
| CHANGE: | R559/RES,MF,10,+-1%,0.125W.100PPM/719443/91637/CMF-55 10ROF T-1/1 |
| TO: | R559,**561**/RES,MF,10,+-1%,0.125W.100PPM/**268789/89536/268789/2** |

On pages 6-19 and 7-8, replace Figures 6-4 and 7-5 as shown in Figure A.

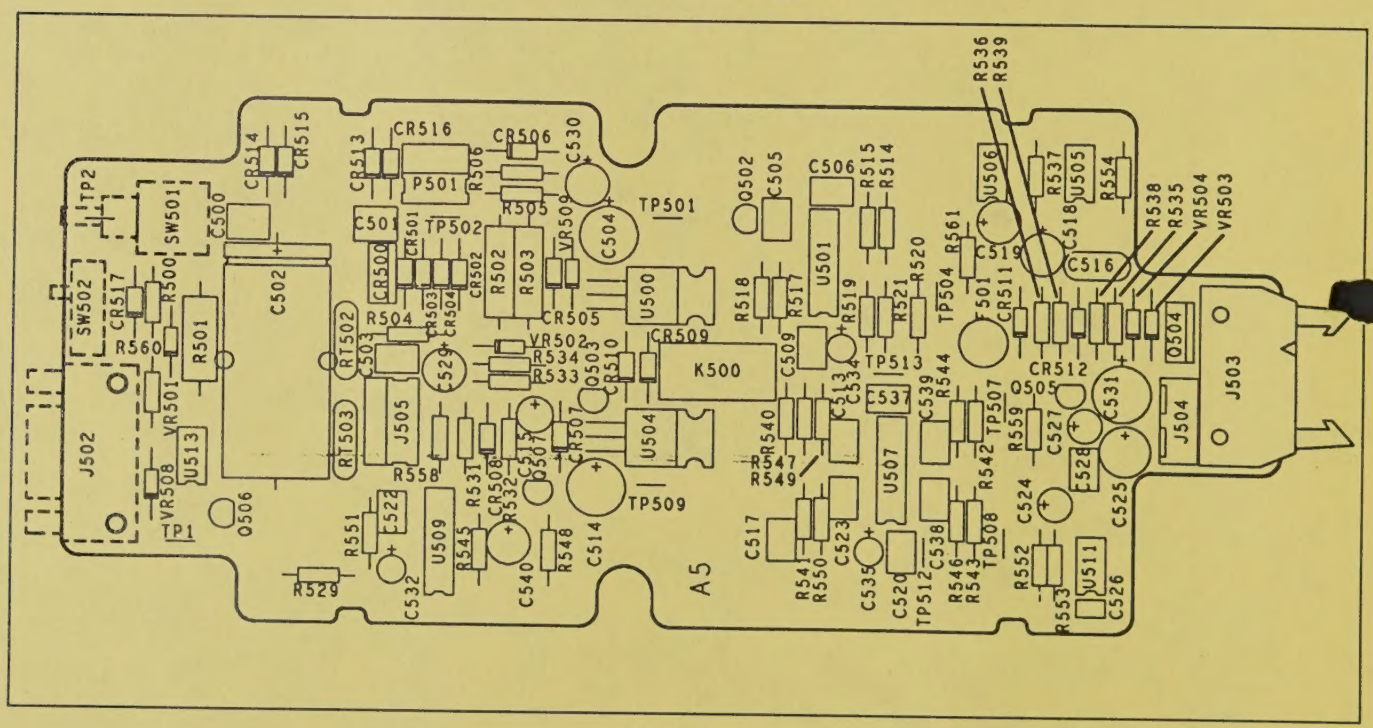


**Figure A.**

On page 7-10, replace part of Figure 7-5 as shown in Figure B.

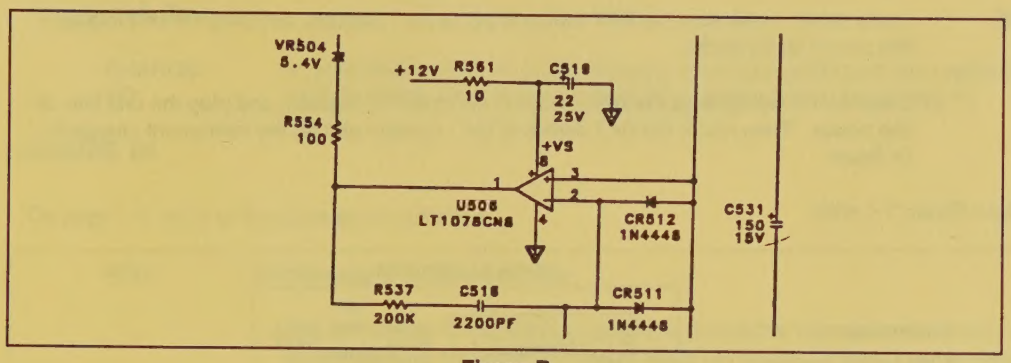


**Figure B.**

## CHANGE #2

On page 5-11, delete the first sentence of step 21. and add the following steps:

ADD: 5a. The "IN CAL" indicator on the front panel will no longer be illuminated. This does not affect the reference if you do not remove the Mains Power from the instrument.

ADD: 20a. Set the BAT switch to the I position.

ADD: 20b. Reset the CAL switch by pressing the button accessible through the rear panel CAL RESET hole with an insulated probe.

## CHANGE #3

On page 1-3, add the following Note! to the end of the IN CAL paragraph.

ADD: Note! An illuminated IN CAL indicator is not sufficient, by itself, to indicate the 732B satisfies the specifications of section 1-12. See Calibration label on front of 732B for calibration due date.

On page 1-7, under OUTPUT CURRENT AND LIMITS,

CHANGE:

| 1.108V |
|---|

TO:

| **1.018V** |
|---|

On page 3-5, row 2, under **DESCRIPTION**, add the Note! to the end of the paragraph.

ADD: Note! An illuminated IN CAL indicator is not sufficient, by itself, to indicate the 732B satisfies the specifications of section 1-12. See Calibration label on front of 732B for calibration due date.

On page 3-12, under **Charging the Internal Battery,**

CHANGE: ...rear panel, make sure the BAT switch is set to the I position, and plug the unit into ac line power for 24 hours.

TO: ...rear panel. Make sure the **BAT** switch is set to the O position, and plug the unit into ac line power. Then return the BAT switch to the I position and let the instrument charge for 24 hours.

On page 5-5, replace Figure 5-1 with:

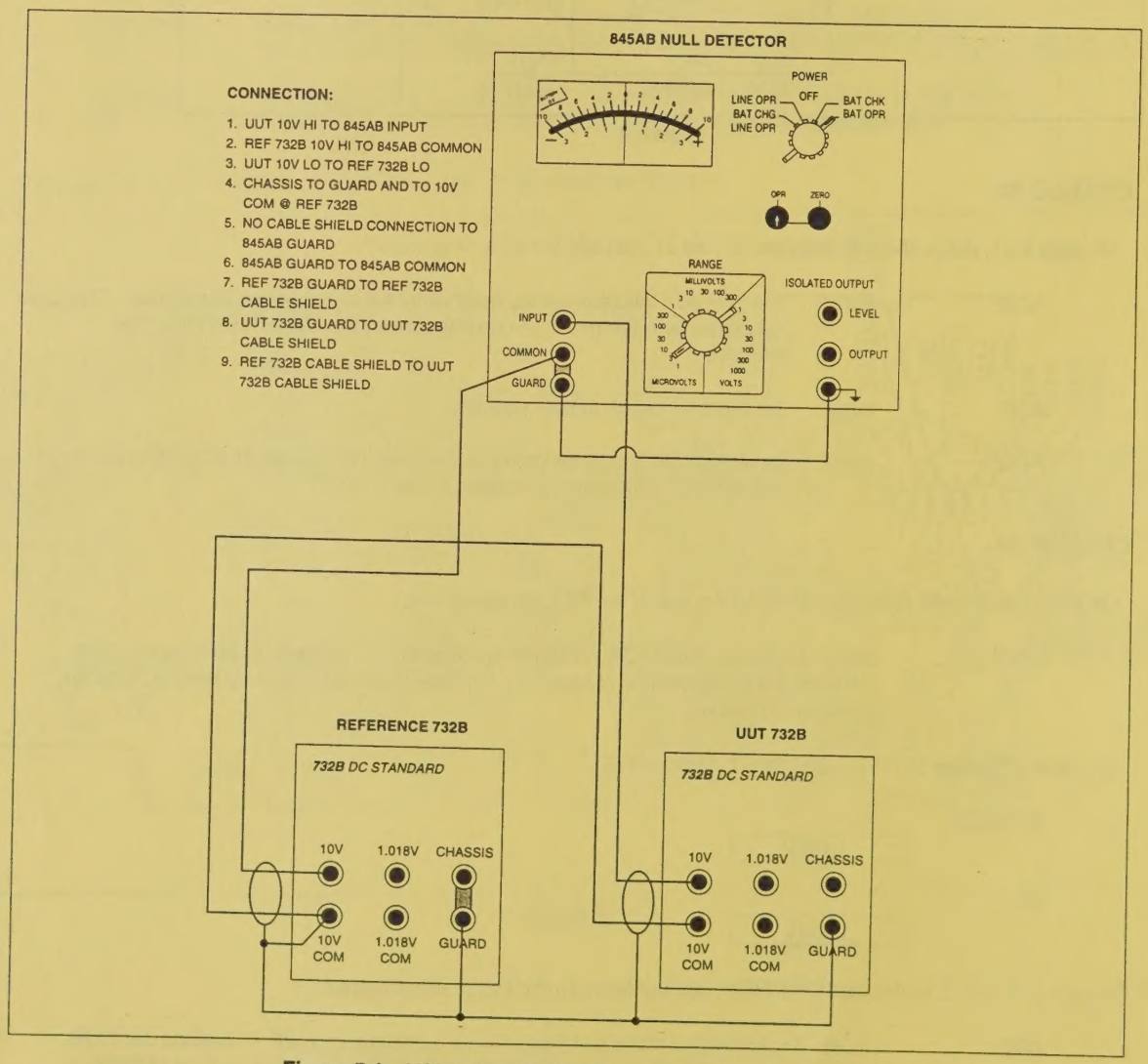


**Figure 5.1. 10V Output Calibration Connections**

## CHANGE #4

On page 6-4, Table 6-1,

CHANGE: H515/SCREW, FHU, P, LOCK,SS,6-32,.250/769893/73734/6-32X1/4FHUCPS2A/22
TO: H515/SCREW, FHU, P, LOCK,SS,6-32,.250/**320093/89536/320093**/22

**CHANGE #5**

On page 6-8, Table 6-2,

CHANGE: H174/SCREW, FHU, P, LOCK,SS,6-32,.250/769893/73734/6-32X1/4FHUCPS2A/16
TO: H174/SCREW, FHU, P, LOCK,SS,6-32,.250/**320093/89536/320093**/16

**CHANGE #6**

On page 1-8, prior to Temperature Coefficient,

ADD: **Electromagnetic Compatibility**

This instrument is designed to operate in Standards Laboratory environments where the radio frequency (RF) enivornment is highly controlled. If used in environments with field strengths >0.18 V/m, there could be errors in measurements.

# 732B/734A

## DC REFERENCE STANDARDS

# Instruction Manual

PN 869321
March 1992
Rev. 2 4/94
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5/94

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We hereby certify that the Fluke Models 732B and 734A are in compliance with BMPT Vfg 243/1991 and is RFI suppressed. The normal operation of some equipment (e.g. signal generators) may be subject to specific restrictions. Please observe the notices in the users manual. The marketing and sale of the equipment was reported to the Central Office for Telecommunication Permits (BZT). The right to retest this equipment or verify compliance with the regulation was given to the BZT.

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# SAFETY SUMMARY

## SAFETY TERMS IN THIS MANUAL

Instrument models described in this manual (Models 732B and 734A) have been designed and tested in accordance with IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus. This Instruction Manual contains information, warnings, and cautions that must be followed to ensure safe operation and to maintain the instrument in a safe condition. Use of these instruments in a manner not specified herein may impair the protection provided by the instrument.

**WARNING** statements identify conditions or practices that could result in personal injury or loss of life.

**CAUTION** statements identify conditions or practices that could result in damage to equipment.

## SYMBOLS MARKED ON EQUIPMENT

Power Off Switch Position


Power On Switch Position

Ground (Earth) Terminal

Attention - refer to the manual. This symbol indicates that information about the use of a feature is contained in the manual.

## POWER SOURCE

The instruments are intended to operate from a power source that will not apply more than 264V ac rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

## USE THE PROPER FUSE

To avoid fire hazard, use only a fuse identical in type, voltage rating, and current rating as specified on the rear panel fuse rating label. Never bypass a fuse by shorting across the fuse terminals.

## GROUNDING THE STANDARD

These are Safety Class I (grounded enclosure) instruments as defined in IEC 348. To avoid electrical shock, plug the power cord into a properly wired earth grounded receptacle, or ground the GROUND binding post before connecting anything else to any of the instrument binding posts. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation when using ac line power.

## USE THE PROPER POWER CORD

Use only the power cord and connector appropriate for the voltage and plug configuration in your country.

Use only a power cord that is in good condition.

Refer cord and connector changes to qualified service personnel.

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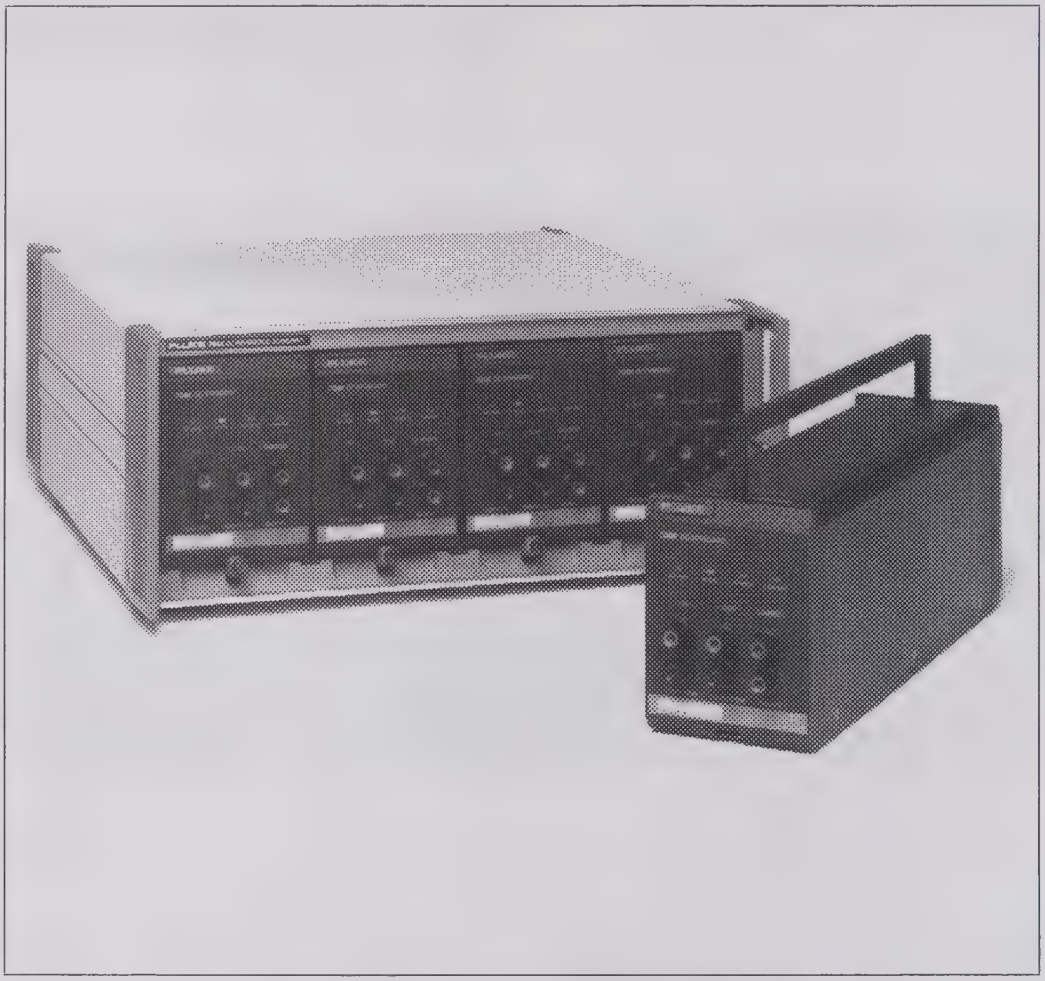

**Models 732B and 734A DC Reference Standards**

# Chapter 1
# Introduction and Specifications

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## INTRODUCTION 1-1.

**CAUTION**

**Set the rear panel BAT switch to | (on) before connecting AC power. This is required for proper instrument operation. If your 732B was shipped cold, you will need to calibrate it against a traceable standard as described in Section 5 before you begin using it. For best results, leave the standard powered for a minimum of 14 days before you calibrate and begin using it.**

Model 732B is a dc voltage laboratory standard that produces reference voltages of 10V and 1.018V. Model 734A contains four 732B DC Standards in a chassis. The 732B is highly stable, rugged and transportable. Its 10V output excels in stability, and can be used as your direct link in the traceability chain to national standards. You can use the 732B 1.018V output to transfer the "volt" at the 1.018V level from one set of saturated standard cells to another. You can also use the 1.018V output as a working standard with older equipment that requires a standard cell voltage input.

The 10V output's long-term stability, predictable drift rate, low uncertainty, convenient level, and immunity to accidental damage make the 732B or 734A the preferred artifact for maintaining a local standard of voltage. With time characterization (Calibration Option 732B-100) the drift rate for the 10V output is given. This reduces the 10V output uncertainty from 2 ppm/year to 1 ppm/year.

All outputs of the 732B can withstand short circuit indefinitely, without damage to the instrument or disruption of the state of calibration. Recovery time for a momentary short is less than 2 minutes; for an extended short, recover time is less than 2 hours.

To maintain calibration as a traceable standard, the 732B must continue to receive uninterrupted operating voltage from ac line power or from the internal battery. If battery voltage drops too low, the front panel IN CAL indicator goes out and recalibration is required.

The internal rechargeable battery (if switched on) protects the standard from line power interruption and provides power for hot shipment (shipment under power). The 732B outputs are unaffected as you change between battery or ac line power. Battery operation with a fully charged battery lasts at least 72 hours. You can extend battery operation by connecting an external 12V battery such as Model 732B-7001 to the rear panel MONITOR/EXT BAT IN connector. Plugging the 732B into ac line power for 24 hours fully recharges the internal battery.

Four front panel indicators show operating status. Model 732B-7001 External Battery/Charger has all but the IN CAL indicator.

- AC PWR lights when the 732B is connected to ac line power.
- IN CAL goes out to warn you when the 732B may have lost its calibration. This indicator responds to an excessively large drop in battery voltage or a large change in oven temperature. If battery voltage falls below the level needed to keep the 732B working normally, the IN CAL indicator extinguishes, indicating a loss of the state of calibration. Once power is restored and the output has been verified, you can reset the IN CAL indicator.
- LOW BAT blinks to warn you to plug the line cord into ac power when only a few hours of battery operation remain.
- CHARGE lights when the battery is being recharged in constant-current charge mode, and is off when the battery is charged to the 90% level. At 90% of full charge, a float charge completes and maintains full charge.

You can monitor the oven temperature by measuring the resistance of the oven temperature thermistor through the rear panel MONITOR/EXT BAT IN connector. Instructions for using this connector are in Section 3.

## HARDWARE OPTIONS 1-2.

Table 1-1 summarizes hardware options for the 732B DC Standard. Calibration Options are described further on in this section.

### 734A-7001 Instrument Enclosure 1-3.

The Model 734A DC Reference Standard is made up of one 734A-7001 Instrument Enclosure and four 732B DC Standards. The Model 734A-7001 can be purchased separately as needed for your application. The enclosure securely holds up to four 732B DC Standards and/or 732B-7001 External Battery/Chargers (described next).

An ac power bus inside the 734A-7001 enclosure powers up to four 732B units with only one ac line cord. Using the enclosure allows you to rack mount 732Bs. (See Y734 Rack Mount Kit.)

### 732B-7001 External Battery and Charger 1-4.

The Model 732B-7001 External Battery and Charger is contained in the same enclosure as the 732B. This means it fits into and is powered by the 734A-7001 Instrument Enclosure just like a 732B DC Standard.

When the external battery is completely charged and connected to a completely charged 732B, it increases 732B battery operating time from 72 to 130 hours. Just as in the 732B, the charger in the 732B-7001 takes 24 hours to completely charge the battery (with no load on the battery). Refer to Section 3 for information about interconnecting 732Bs and 732B-7001s.

### Accessory Y734 Rack Mount Kit 1-5.

To rack mount a 732B, use the 734A-7001 Instrument Enclosure (standard equipment with Model 734A). Use Accessory Y734 Rack Mount Kit to mount the enclosure in a rack. Outside dimensions of the 732B and 734A are shown in the specifications at the end of this section. Instructions for rack mounting the 734A-7001 Instrument Enclosure are packed with the kit.

## CALIBRATION OPTIONS 1-6.

Unless requested at time of order, the 732B is shipped cold (not under battery power) and will need to be calibrated on receipt. A procedure to calibrate a 732B using a reference 732B as a transfer standard is provided in Section 5. After calibration, the 732B must be kept powered by ac power or battery, even during shipment. Fluke calibration services that are available for the 732B are described next.

**Table 1-1. 732B/734A Hardware Options and Accessories**

| Model Number | Name |
|---|---|
| 734A-7001 | Instrument Enclosure |
| 732B-7001 | External Battery and Charger |
| 732B-7002 | Transit Case for two 732Bs or 732B-7001s |
| Y734 | Rack Mount Kit for 734A or 734A-7001 |

*NOTE*

*Contact a Fluke Sales or Service Center for price and delivery information about 732B calibration options. Addresses for Fluke Service Centers are provided following the parts lists in Section 6.*

## 732B-000 Special Calibration 1-7.

If you ordered Option 732B-000, the standard is shipped to you hot with a calibration report that assigns a value to the 10V output. This calibration meets or exceeds the requirements of MIL-STD-45662A.

## 732B-100 Special Calibration and Drift Characterization 1-8.

If you ordered Option 732B-100, the standard is shipped to you hot with a calibration report that assigns a value to the 10V output. This calibration meets or exceeds the requirements of MIL-STD-45662A. In addition, a calibration report shows the predicted output on the 1st of each month for the 12 months following shipment.

## 732B-200 On-Site Calibration 1-9.

Option 732B-200 is the Fluke Direct Volt Maintenance Program, as has been applied to other Fluke dc standards equipment. This program works as follows:

1. Fluke hot-ships a Fluke-owned transfer standard with all the necessary interconnecting cables and clear instructions.

2. You make a series of comparisons over five days and send your data to Fluke.

3. Fluke sends you a calibration report that assigns a value to your 732B 10V output relative to the Fluke Volt. The Fluke Volt is maintained by means of a Josephson Junction array in the Fluke Primary Standards laboratory. Periodic transfers to NIST also maintain traceability to the U.S. Legal Volt (at greater uncertainty) for those who are required to maintain NIST traceability.

## WARRANTY INFORMATION 1-10.

The warranty that applies to your Fluke product appears on the inside front cover of this manual.

## SERVICE AND RESHIPMENT INFORMATION 1-11.

**WARNING**

**SERVICE PROCEDURES, INCLUDING REPLACING THE BATTERIES, ARE TO BE DONE BY QUALIFIED SERVICE PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK OR FIRE, DO NOT SERVICE THE 732B UNLESS YOU ARE QUALIFIED TO DO SO.**

If your standard ever needs service, you may return it to Fluke for Warranty or after-warranty repair. Addresses for Fluke Sales and Service Centers are in Section 6. If you are qualified to troubleshoot electronic equipment, you can refer to Section 5 for theory, troubleshooting, and calibration information. Schematic diagrams are in Section 7.

The 732B and 734A are designed to withstand the shock and vibration of air and ground shipment, provided that you protect the equipment with a proper shipping container. When you return a 732B or 734A to Fluke for service or calibration, use the original shipping carton, a replacement carton obtained from Fluke, or the accessory transit case. Transit Case Model 732B-7002 holds two 732B DC Standards or 732B-7001 External Battery/Chargers.

**CAUTION**

**Do not charge a 732B or 732B-7001 while it is in the transit case. Doing so can cause overheating and possible equipment damage, and in the case of the 732B, loss of the state of calibration.**

## SPECIFICATIONS 1-12.

### Output Voltages

10V and 1.018V are provided at separate binding post pairs with the following characteristics:

*NOTE*

*A potential difference of approximately <200 μV exists between the floating 1.018V LO and 10V LO terminals. Consequently, buck measurements cannot be made between these sources without taking this into account.*

### STABILITY

Stability for a given period of time is defined as the output uncertainty minus the calibration uncertainty at the 99% Confidence Level. When the output voltage is characterized by a regression model, stability is given by the following equation:

$$\left| b\left(\frac{P}{365}\right) + 2.6S_1 \sqrt{\left[\frac{S_{ra}}{S_1}\right]^2 + \left(\frac{1}{n}\right) + \left[\frac{(\bar{x} + P - x_1)^2}{\Sigma (X_j - \bar{x})^2}\right]} \right|$$

where b = slope of regression in ppm/year

$S_1$ = standard deviation about the regression (SDEV)

$S_{ra}$ = SDEV of data filtered with 7-day moving average filter (MAF)

P = Period of time under consideration in days

$\bar{x}$ = mean time for regression data

n = 180 periods (typically 2 measurements per day)

Xj = jth period

$X_1$ = time at beginning of data

Each data point for the computation of the regression parameters is the average voltage of 50 readings taken in a 50-second measurement period.

Stability for the 732B outputs at 23 ±1°C is specified as follows:

| OUTPUT VOLTAGE | STABILITY (± PPM) | | |
|---|---|---|---|
| | 30 DAYS | 90 DAYS | 1 YEAR |
| 10V | 0.3 | 0.8 | 2.0 |
| 1.018V | 0.8 | NA | NA |

## NOISE AT THE OUTPUT TERMINALS

Output noise is specified for both day-to-day observations and for short-term observations. The former is given by the standard deviation of a 90-day regression model. The latter is in terms of its rms value in a bandwidth as follows:

| OUTPUT VOLTAGE | $S_1$ (± PPM) | $S_{ra}$ (± PPM) | NOISE (0.01 Hz to 10 Hz) (± PPM RMS) |
|---|---|---|---|
| 10V | 0.068 | 0.05 | 0.06 |
| 1.018V | 0.1 | NA | 0.03 |

## OUTPUT CURRENT AND LIMITS

| OUTPUT VOLTAGE | OUTPUT CURRENT LIMIT | OUTPUT IMPEDANCE |
|---|---|---|
| 10V | 12 mA (NOTE) | <= 1 mΩ |
| 1.108V | 20 pA | <= 1 kΩ |
| NOTE: Limit output current to <= 0.1 mA to realize 72 hour battery operation. | | |

## OUTPUT ADJUSTABILITY

10V: 0.15 ppm resolution
1.018V: Set at nominal ±1 mV. No adjustment is provided.

The 10V adjustment is done with a set of four decade-control switches with a range of at least 4 mV.

## RETRACE (HYSTERESIS) ERROR

The following table shows the change in 10V output voltage following a power outage (with the battery turned off) with temperature held constant in the normal operating range.

| PERIOD THAT POWER IS TURNED OFF | CHANGE IN 10V OUTPUT VALUE |
|---|---|
| 10 minutes or less | <= ±0.1 ppm |
| 10 minutes to 24 hours | <= ±0.25 ppm |

## STABILIZATION TIME REQUIREMENTS

The following information specifies the warmup times required after ac line and battery power has been turned off. The IN CAL indicator will be off, and recalibration will be necessary. The previously specified retrace error specification can be used in the case of brief power interruptions.

| | |
|---|---|
| With no power interruption: | No stabilization time is required after moving into another environment. |
| Power off for less than 1 hour: | 1-hour warmup required |
| Power off for 1 to 24 hours | 24-hour warmup required |

## TEMPERATURE COEFFICIENT (TC) OF OUTPUT

In the temperature range of 15°C to 35°C, the magnitude of the TC is bounded by the following:

10V Output: TC <= 0.04 ppm/°C
1.018V Output: TC <= 0.1 ppm/°C

## LOAD REGULATION

| 10V OUTPUT LOAD CHANGE | MAXIMUM 10V OUTPUT CHANGE |
|---|---|
| 0 mA to 12 mA (no load to full load) | ±1 ppm |
| 0 mA to 2 mA | ±0.1 ppm |

## LINE REGULATION

The outputs will change no more than 0.05 ppm for any 10% line voltage change or for the entire operating range of the battery.

## OUTPUT PROTECTION

All outputs can be shorted indefinitely without damage to the instrument. The 10V output can withstand voltages from other sources as follows:

1. For voltages <=220V dc, the unit is protected for up to 50 mA continuous current.

2. For voltage <=1100V dc, the unit is protected for up to 25 mA continuous current or up to 0.6 joules for short periods of time.

## ENVIRONMENT

| | TEMPERATURE RANGE | RELATIVE HUMIDITY | ALTITUDE |
|---|---|---|---|
| Normal Operation | 15°C to 35°C | 15% to 80% | 0 to 6,000 ft |
| Safe Operation | 0°C to 50°C | 15% to 90% | 0 to 10,000 ft |
| Storage (With battery removed) | -40°C to 50°C | Noncondensing | 0 to 40,000 ft |

## COMPLIANCE TO STANDARDS

ANSI/ISA-S82
CSA C22.2 #231
IEC348
IEC 1010
UL 1244

## LINE POWER REQUIREMENTS

Line voltage is accepted in the two ranges 90 to 132V and 180 to 264V, at 47 to 63 Hz as shown in the table below. AC line current at 120V ac is 0.13A.

| 732B LINE VOLTAGE SETTING | LINE VOLTAGE ACCEPTED | FREQUENCY ACCEPTED |
|---|---|---|
| 100V | 90 to 110V | 47 to 63 Hz |
| 120V | 108 to 132V | 47 to 63 Hz |
| 220V | 180 to 235V | 47 to 63 Hz |
| 240V | 225 to 264V | 47 to 63 Hz |

## BATTERY OPERATION

When fully charged, the internal batteries will operate the 732B for a minimum of 72 hours at 23 ±5°C, with 0 to 0.1 mA current drain at the 10V output. Model 732B-7001 contains the same battery and charger as Model 732B.

### Charging Time

The batteries are rechargeable in less than 24 hours with a self-contained automatic battery charger.

### External DC Input

A rear panel input for external 12 to 15V dc allows for powering the 732B indefinitely. The dc source must be rated for 300 mA or more.

## ISOLATION

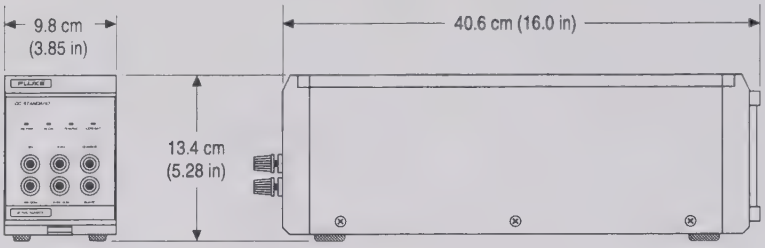
The resistance from any of the 732B binding posts to earth (chassis) ground or to ac line power is greater than 10,000 MΩ shunted by less than 1000 pF.

## GUARD AND GROUND TERMINALS

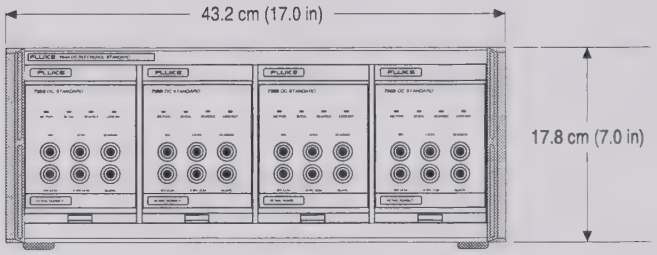
Chassis ground connections are provided on both the front and rear panels. Access to the internal guard is provided by a front panel binding post.

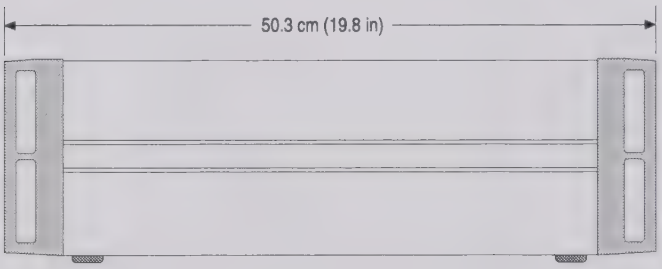
## MECHANICAL SPECIFICATIONS

| | Model 734A | Model 732B | Model 732B-7001 |
|---|---|---|---|
| Height | 17.8 cm (7.0 in) | 13.4 cm (5.28 in) | 13.4 cm (5.28 in) |
| Width | 43.2 cm (17.0 in) | 9.8 cm (3.85 in) | 9.8 cm (3.85 in) |
| Depth | 50.3 cm (19.8 in) Including handles | 40.6 cm (16.0 in) | 40.6 cm (16.0 in) |
| Weight | 30.4 kg (67 lb) | 5.91 kg (13 lb) | 5.91 kg (13 lb) |


9.8 cm
(3.85 in)
40.6 cm (16.0 in)
13.4 cm
(5.28 in)

**732B**


43.2 cm (17.0 in)
17.8 cm (7.0 in)


50.3 cm (19.8 in)

**734A**

# Chapter 2
# Installation

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2-5. INSTALLING A 732B OR 732B-7001 IN A 734A-7001 INSTRUMENT ENCLOSURE .... 2-5

## INTRODUCTION 2-1.

This section provides instructions for the following:

- Unpacking
- Installation
- Selecting line voltage
- Checking or replacing the fuse
- Connecting to line power

Because this section explains fusing and operating environment requirements, you should read this section before operating the standard. Section 3 contains instructions for operating your standard.

## UNPACKING AND INSPECTION 2-2.

The 732B and 734A are shipped in a container that is specially designed to prevent damage during shipping. However, you should inspect the standard carefully for damage, and immediately report any damage to the shipper. Instructions for inspection and claims are included in the shipping container. If you need to reship the 732B, refer to Service and Reshipment Information in Section 1.

If you ordered your 732B with calibration option 732B-000 or 732B-100, the standard is shipped hot (under battery power) to maintain the state of calibration. Verify that the IN CAL indicator is lit. Immediately refer to the fusing and line voltage instructions in this section, and plug the standard into ac line power.

Accompanying the standard should be an ac line power cord appropriate for your country. Line power cords available from Fluke are listed in Table 2-2 and illustrated in Figure 2-1. If you have any questions about the contents of the carton you are unpacking, contact the nearest Fluke Service Center. (A List of Service Centers is located in Appendix A of this manual.)

For more information about calibration options, refer to Section 1. If a verification test is required for your acceptance procedures, refer to Section 5 for instructions.

**Table 2-1. Standard Equipment**

| ITEM | MODEL OR PART NUMBER |
|---|---|
| AC Line Cord | (See Table 2-2 and Figure 2-1) |
| 732B/734A Instruction Manual | 871723 |

**Table 2-2. AC Line Cords Available for Fluke Instruments**

| TYPE | VOLTAGE/CURRENT | FLUKE OPTION NUMBER |
|---|---|---|
| North American | 120V/15A | LC-1 |
| North American | 240V/15A | LC-2 |
| Universal Euro | 220V/16A | LC-3 |
| United Kingdom | 240V/13A | LC-4 |
| Switzerland | 220V/10A | LC-5 |
| Australian | 240V/10A | LC-6 |
| South African | 240V/5A | LC-7 |

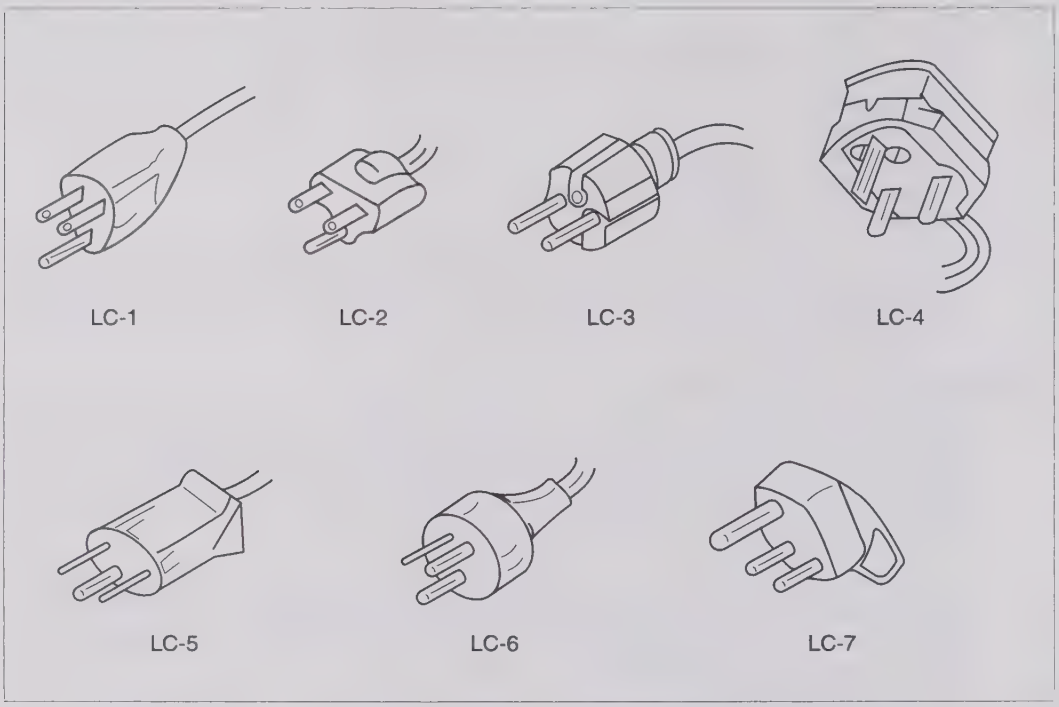


**Figure 2-1. Line Power Cords Available for Fluke Instruments**

## SELECTING LINE VOLTAGE AND ACCESSING THE FUSE 2-3.

**CAUTION**

**To avoid blowing the ac line fuse, verify the position of the line voltage selection drum before plugging in the line cord. Rotate the drum if necessary to match local line power.**

**CAUTION**

**To prevent instrument damage, verify that a 1/4A, 250V SLOW BLOW fuse is installed. No other rating or type of fuse is acceptable.**

The ac input module on the rear panel has four line voltage settings: 100V, 120V, 220V, and 240V. Each voltage setting has a voltage tolerance of ±10% and accepts line frequencies of 50 or 60 Hz.

To select line voltage and verify the fuse, or to replace the fuse, refer to Figure 2-2, and proceed as follows:

1. Disconnect the ac line cord from the wall outlet and the rear panel.
2. Using a small screwdriver, pop open the line voltage selection module door from the top.
3. Using the screwdriver, pry the tab of the fuse holder to slide out the fuse holder.
4. Verify the fuse type and rating using the data on the rear panel or Figure 2-2, and replace it.

5. If you need to change the line voltage setting, remove the drum and rotate it so that the desired voltage is facing outward. Replace the drum.

6. Close the line voltage selection module door. Verify that the line voltage you selected is showing through the window.

## CONNECTING TO LINE POWER 2-4.

**WARNING**

**TO AVOID ELECTRIC SHOCK WHILE CHARGING OR USING THE STANDARD WITH THE LINE CORD PLUGGED IN, CONNECT THE FACTORY SUPPLIED, THREE-CONDUCTOR LINE POWER CORD TO A PROPERLY GROUNDED POWER OUTLET. DO NOT USE A TWO-CONDUCTOR ADAPTER OR EXTENSION CORD TO OPEN THE PROTECTIVE GROUND CONNECTION.**

**CAUTION**

**To avoid loss of the state of calibration in case of ac power interruption, set the BAT switch to | (on). This enables battery backup power.**

After verifying that the line voltage setting and fuse are correct, connect the line cord to the rear panel ac input plug, and plug the line cord into a properly grounded three-prong outlet. Verify that the AC PWR indicator is lit. If it is not, check for an open fuse. In case of further difficulty, refer to Section 5 for troubleshooting information.

The 732B and 732B-7001 are IEC Safety Class I (grounded enclosure) instruments, and must be properly connected to earth ground when plugged into ac line power. When the ac line cord is plugged into a properly grounded three-prong outlet, the safety ground path for the battery charger is through the line cord ground lead.

*NOTE*

*Refer to Section 3 for additional information about powering the standard from the ac line or the internal battery.*

## INSTALLING A 732B OR 732B-7001 IN A 734A-7001 INSTRUMENT ENCLOSURE 2-5.

When you slide a 732B or 732B-7001 into one of the instrument bays in the chassis, it automatically connects to the ac power bus. The 734A-7001 Instrument Enclosure provides an ac line power bus only. There is no fuse in the 734A-7001. All fusing and line voltage selection is done in the installed 732Bs and 732B-7001s.

To install a 732B or 732B-7001 in a 734A-7001 Instrument Enclosure, refer to Figure 2-3 and proceed as follows:

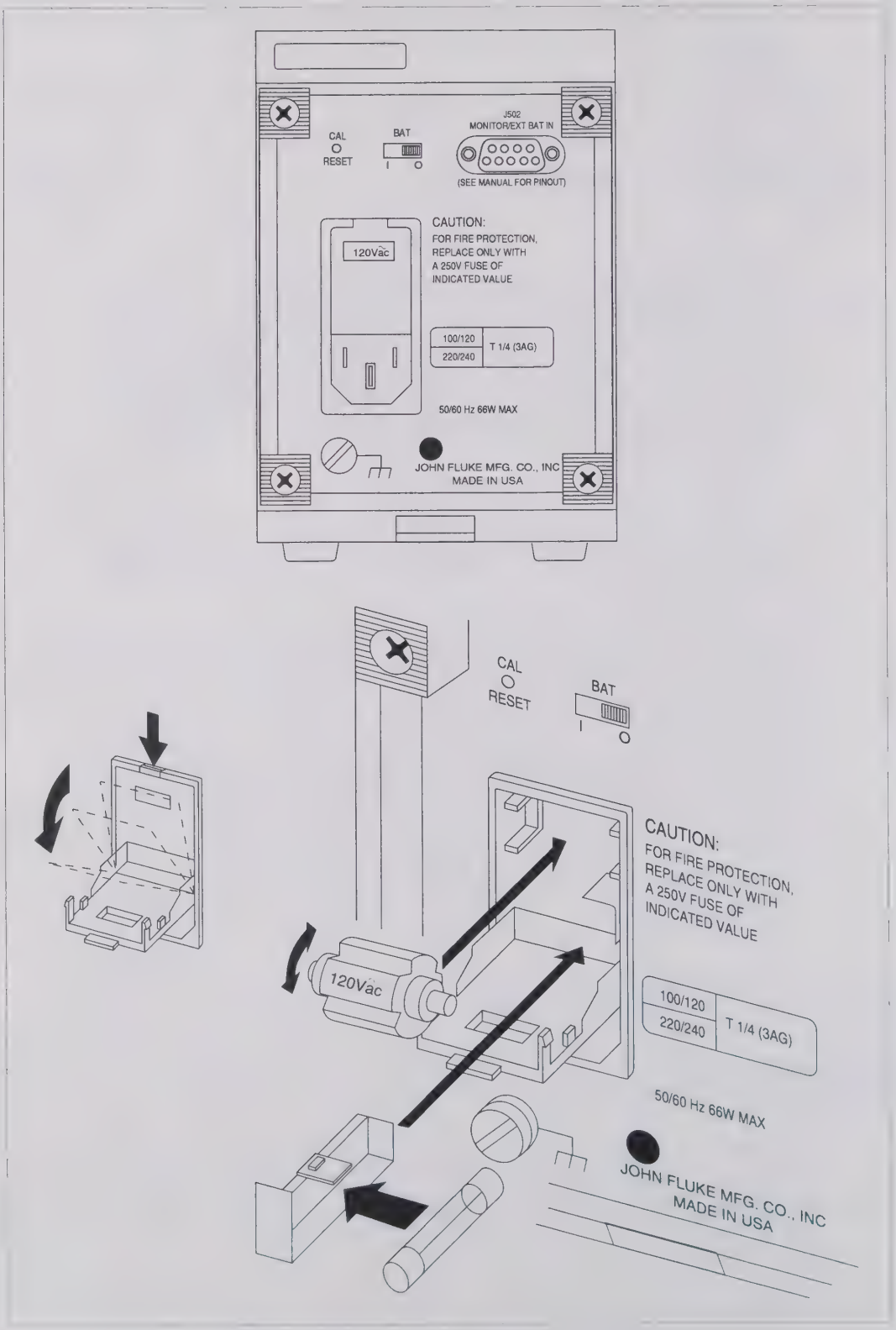


**Figure 2-2. Line Power Label and Fuse Location**

1. Remove the enclosure ac line cord from line power.
2. Verify that the 732B or 732B-7001 BAT switch is set to | and disconnect line power from the 732B or 732B-7001.
3. Insert the 732B or 732B-7001 into one of the four instrument bays. Guides along the bottom and a rear panel alignment stud inside the enclosure ensure correct installation.
4. When the unit is fully installed, lift and engage the locking lever at the bottom of the 732B or 732B-7001 front panel and finger-tighten the thumbscrew.
5. Prepare and connect cables to the rear panel MONITOR/EXT BAT IN (Model 732B) or BAT OUT (Model 732B-7001) connectors as described in Section 3.
6. Connect the enclosure's ac line cord to a grounded three-prong ac outlet. All units installed in the chassis are powered by this line cord.

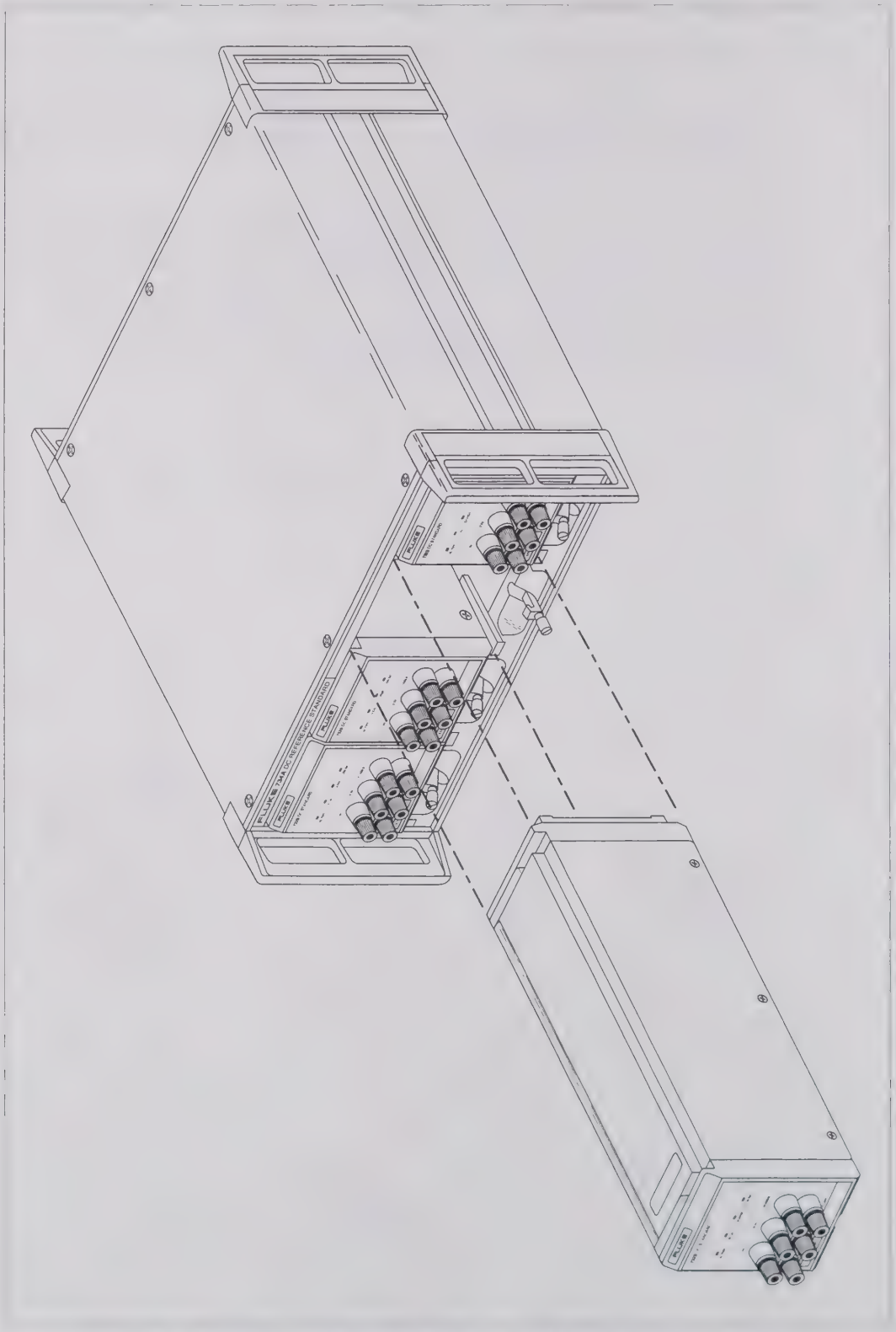

**Figure 2-3. Installing a 732B or 732B-7001 in a 734A-7001 Instrument Enclosure**

# Chapter 3
# Operation

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## INTRODUCTION 3-1.

Information in this section tells you how to operate the 732B and 734A on battery and ac line power. This section begins with a description of the features of the models covered in this manual. Instructions for how to power the standard, connect it to other instruments, and use it to make a voltage transfer follow. Other operating topics, including minimization of errors during measurements, are included here.

Unless you purchased a calibration option and shipment under battery power (see Section 1 or a Fluke Catalog for details), the 732B is shipped from the factory with the internal battery disconnected. (The BAT switch on the rear panel is in the position marked **O**). On receipt, connect the ac line cord to line power as described in Section 2, and set the BAT switch to the position marked |. Verify that the AC PWR indicator is lit.

*NOTE*

*If your 732B was shipped cold, you will need to calibrate it against a traceable standard as described in Section 5 before you begin using it. For best results, leave the standard powered for 14 days before you calibrate and begin using it.*

To maintain the state of calibration as a traceable standard, the 732B must continue to receive uninterrupted operating voltage from the line power or from the internal battery, which provides approximately 72 hours of off-line operation when fully charged.

## SUMMARY OF THE FEATURES 3-2.

Please read the following summary of features before you begin using the standard. Separate illustrations and tables describe the functions and locations of features on the 732B DC Standard, 732B-7001 External Battery and Charger, and 734A-7001 Instrument Enclosure.

### 732B DC Standard Front Panel 3-3.

Figure 3-1 shows the 732B DC Standard front panel features. Table 3-1 describes these features.

### 732B DC Standard Rear Panel 3-4.

Figure 3-2 shows the 732B DC Standard rear panel features. Table 3-2 describes these features.

### 732B-7001 External Battery and Charger Front Panel 3-5.

Figure 3-3 shows the 732B-7001 External Battery and Charger front panel features. Table 3-3 describes these features.

### 732B-7001 External Battery and Charger Rear Panel 3-6.

Figure 3-4 shows the 732B-7001 External Battery and Charger rear panel features. Table 3-4 describes these features.

### 734A-7001 Instrument Enclosure Front Panel 3-7.

Figure 3-5 shows the 732A-7001 Instrument Enclosure front panel features. Table 3-5 describes these features.

### 734A-7001 Instrument Enclosure Rear Panel 3-8.

Figure 3-6 shows the 732A-7001 Instrument Enclosure rear panel features. Table 3-6 describes these features.

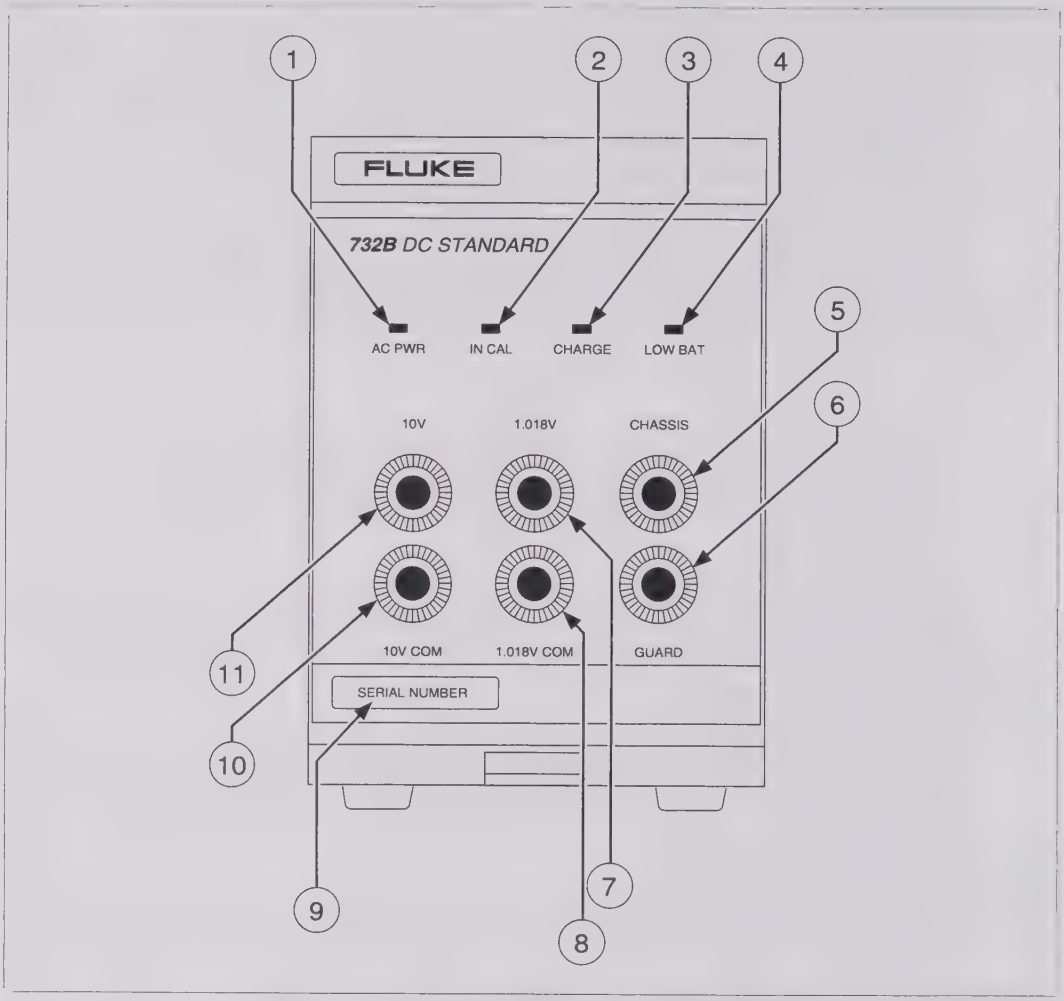


**Figure 3-1. 732B DC Standard Front Panel Features**

**Table 3-1. 732B DC Standard Front Panel Features**

| ITEM | FEATURE | DESCRIPTION |
|---|---|---|
| 1 | AC PWR Indicator | Lights whenever the standard is connected to ac line power. |
| 2 | IN CAL Indicator | Goes out to warn you when a loss of calibration may have occurred. This indicator responds to excessive drops in battery operating voltage and gross changes in oven temperature. Once you have recalibrated the 732B, you can reset the IN CAL indicator by pressing the recessed rear panel CAL RESET switch. |
| 3 | CHARGE Indicator | Lights when the internal battery is in the constant-current charging mode. The rear panel BATTERY switch must be in the I position to charge the battery. When the battery is near full charge, the CHARGE indicator goes off, and the charging circuit goes into float-charging mode to complete and maintain full charge. |
| 4 | LOW BAT Indicator | Blinks when approximately 5 hours of battery operation time remains. When LOW BAT blinks, plug the standard into ac line power as soon as possible to avoid extinguishing the IN CAL indicator and invalidating the state of calibration. |
| 5 | CHASSIS Binding Post | A connection point for chassis ground. You can use this connector when operating on battery power to ground the chassis to the earth ground point in a system of interconnected instruments. Another chassis ground connection is on the rear panel. |
| 6 | GUARD Binding Post | The connection point for the internal voltage guard. Refer to the text in this section for instructions on use of the GUARD connection. |
| 7 | 1.018V Binding Post | The positive connection for the 1.018V output. |
| 8 | 1.018V COM Binding Post | The common connection for the 1.018V output. |
| 9 | Serial Number | Use this identifier in your correspondence with Fluke. |
| 10 | 10V COM Binding Post | The common connection for the 10V output. |
| 11 | 10V Binding Post | The positive connection for the 10V output. |

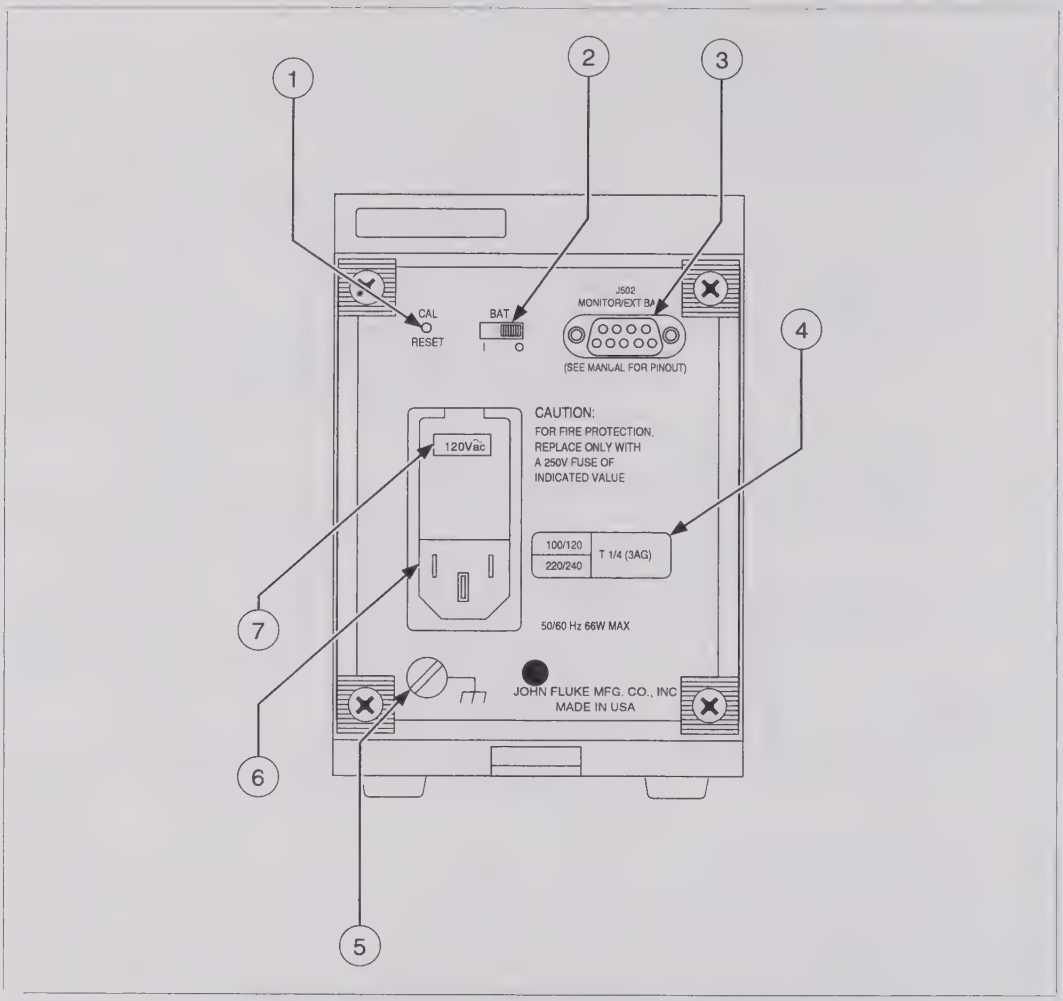


**Figure 3-2. 732B DC Standard Rear Panel Features**

**Table 3-2. 732B DC Standard Rear Panel Features**

| ITEM | FEATURE | DESCRIPTION |
|---|---|---|
| 1 | Recessed CAL RESET Switch | If the IN CAL indicator is off and normal 732B operating conditions are met, pressing this momentary-contact switch resets IN CAL. You should calibrate the 732B before resetting the IN CAL indicator. Normally, a calibration sticker covers the hole to prevent tampering with this control. |
| 2 | BATTERY Switch | Connects and disconnects the battery from the charger and reference circuitry. |
| 3 | MONITOR/EXT BAT IN Connector | Provides the input/output point for three functions: (1) powering the standard from external 12 to 15V dc. (2) Measuring the resistance of the oven temperature thermistor. (3) Remotely monitoring the IN CAL indicator state. |
| 4 | Fuse Type and Rating Label | States the correct fuse type and rating for use in the 100, 120, 220, and 240V settings. Use of an improper fuse defeats the safety design of the standard and can cause instrument damage. |
| 5 | CHASSIS Connector | A connection point for chassis ground. You can use this connector to ground the chassis to the earth ground point in a system of interconnected instruments. Another chassis ground connection is on the front panel. (See the text in this section for more information about guarding and grounding.) |
| 6 | Line Cord Plug and Fuse Holder | Houses the ac line fuse and the male three-prong connector for an IEC-type power cord. The plastic cover fits over the fuse so it can be accessed only when the power cord is not connected. |
| 7 | Line Voltage Selector | Allows selection of four ac line voltage settings, 100, 120, 220, and 240V, each with a tolerance of 10%. The accepted line frequencies are 50 and 60 Hz. |

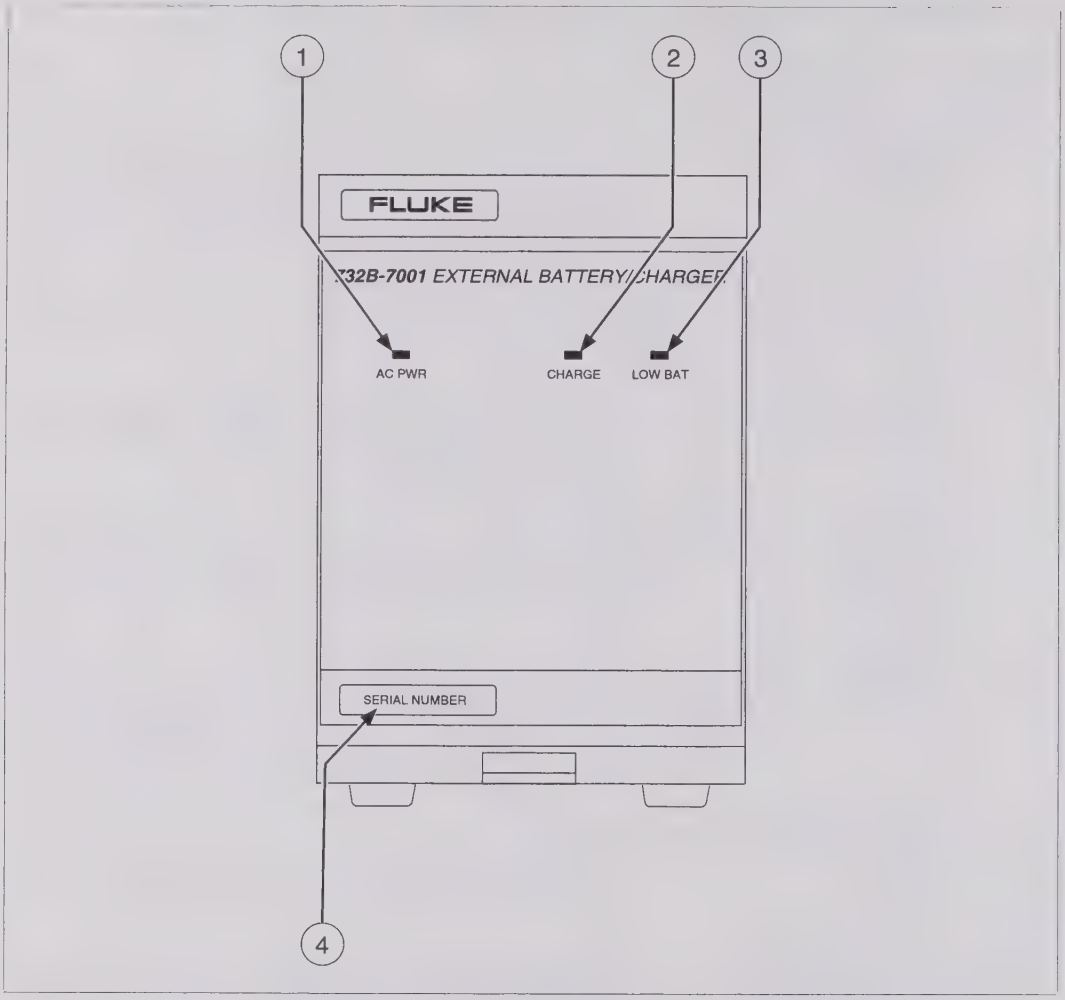


**Figure 3-3. 732B-7001 External Battery/Charger Front Panel Features**

**Table 3-3. 732B-7001 External Battery/Charger Front Panel Features**

| ITEM | FEATURE | DESCRIPTION |
|---|---|---|
| 1 | AC PWR Indicator | Lights whenever the battery unit is connected to ac line power. |
| 2 | CHARGE Indicator | Lights when the battery unit is in the constant-current charging mode. When the battery is near full charge, the CHARGE indicator goes off, and the charging circuit goes into float-charging mode to complete and maintain full charge. |
| 3 | LOW BAT Indicator | Blinks when approximately 5 hours of battery operation time remain. When LOW BAT blinks, plug the battery unit into ac line power as soon as possible to avoid loss of power to an attached 732B DC Standard. |
| 4 | Serial Number | Use this identifier in your correspondence with Fluke. |

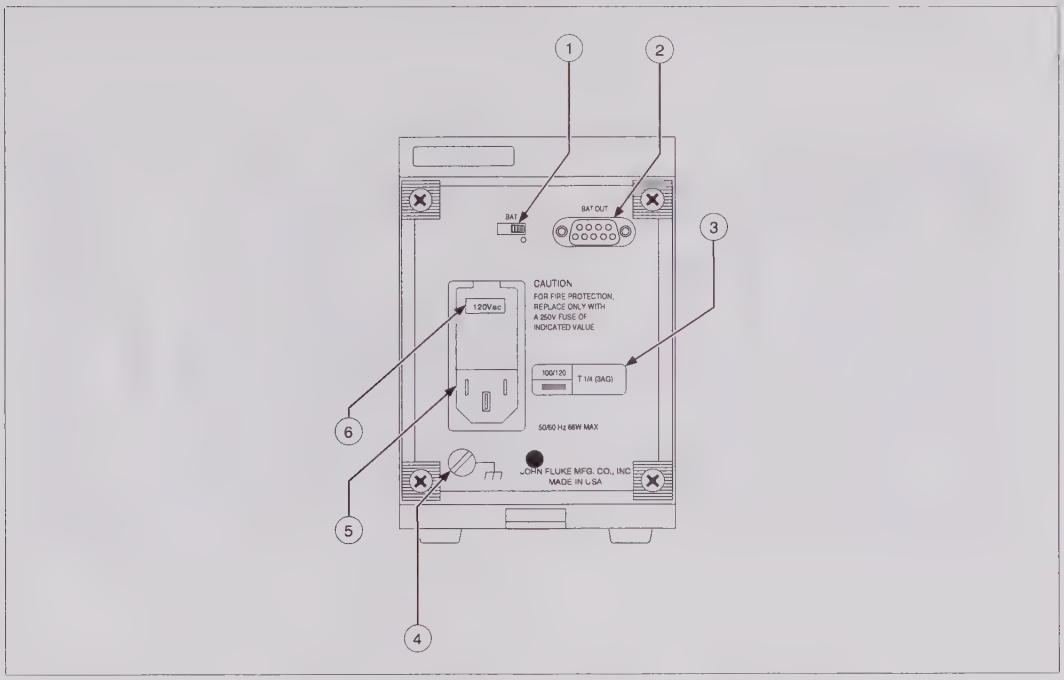


**Figure 3-4. 732B-7001 External Battery/Charger Rear Panel Features**

**Table 3-4. 732B-7001 External Battery/Charger Rear Panel Features**

| ITEM | FEATURE | DESCRIPTION |
|---|---|---|
| 1 | BATTERY Switch | Connects and disconnects the battery from the internal charger. |
| 2 | BAT OUT Connector | Provides the connection point for dc output from the battery unit. Pins 5 and 9 are the dc voltage positive line, and pins 1 and 6 are the dc voltage negative line. All other pins are not used. |
| 3 | Fuse Type and Rating Label | States the correct fuse type and rating for use in the 100, 120, 220, and 240V settings. Use of an improper fuse defeats the safety design of the unit and can cause damage. |
| 4 | CHASSIS Connector | A connection point for chassis ground. You can use this connector when operating on battery power to ground the chassis to the earth ground point in a system of interconnected instruments. Another chassis ground connection is on the front panel. (See the text in this section for more information about guarding and grounding.) |
| 5 | Line Cord Plug and Fuse Holder | Houses the ac line fuse and the male three-prong connector for an IEC-type power cord. The plastic cover fits over the fuse so it can be accessed only when the power cord is not connected. |
| 6 | Line Voltage Selector | Allows selection of four ac line voltage settings, 100, 120, 220, and 240V, each with a tolerance of 10%. The accepted line frequencies are 50 and 60 Hz. |

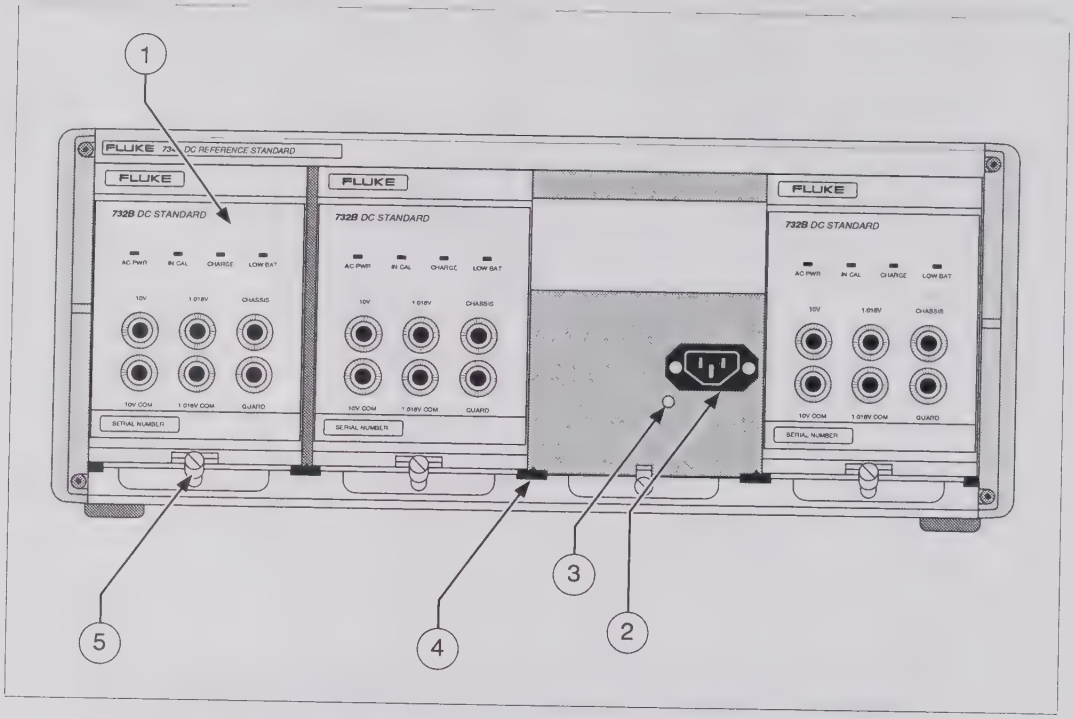


**Figure 3-5. 734A-7001 Instrument Enclosure Front Panel Features**

**Table 3-5. 734A-7001 Instrument Enclosure Front Panel Features**

| ITEM | FEATURE | DESCRIPTION |
|---|---|---|
| 1 | Instrument Bay | There are four instrument bays in the 734A-7001 Instrument Enclosure. Each holds one Model 732B or 732B-7001 unit. |
| 2 | AC Power Bus Connector | This internal connector automatically mates with the 732B or 732B-7001 rear panel ac power input when you install a 732B unit into the enclosure. |
| 3 | Alignment Pin | This alignment pin mates with an alignment hole on the rear panel of the 732B or 732B-7001. It ensures that the ac line connectors are aligned. |
| 4 | Guide | Guides separate each instrument bay. |
| 5 | Locking Lever | Tighten the screw to lock a 732B or 732B-7001 in place inside the instrument enclosure. |

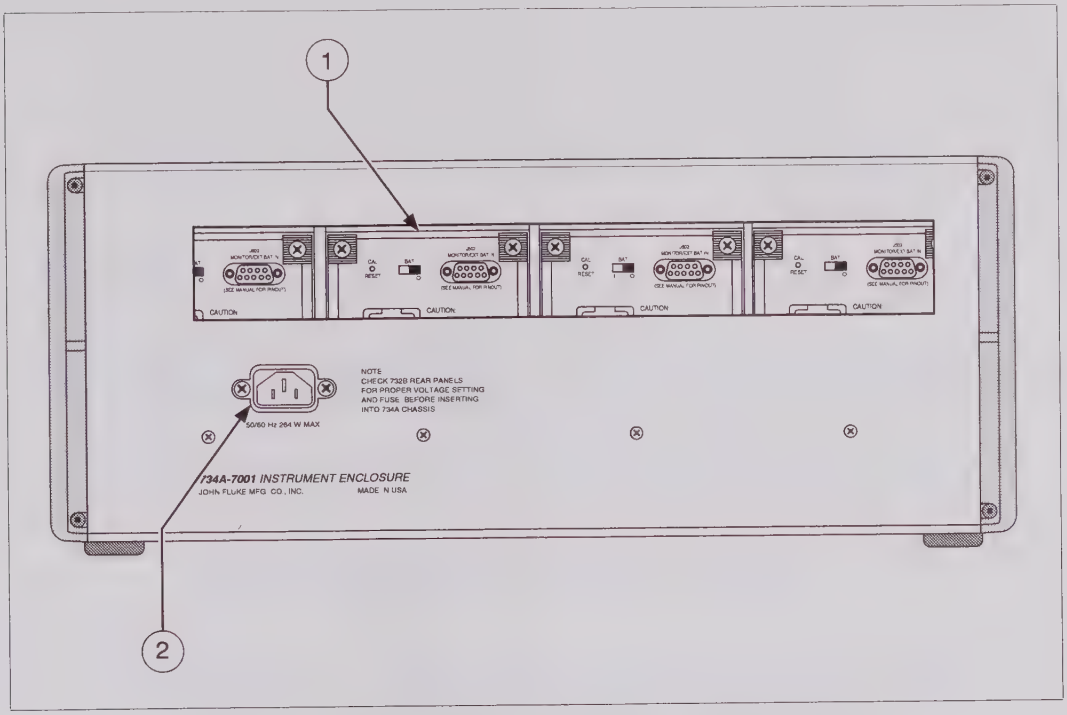


**Figure 3-6. 734A-7001 Instrument Enclosure Rear Panel Features**

**Table 3-6. 734A-7001 Instrument Enclosure Rear Panel Features**

| ITEM | FEATURE | DESCRIPTION |
|---|---|---|
| 1 | Access Window | This opening provides access to BAT switches and MONITOR/EXT BAT IN or EXT BAT OUT connectors on installed 732B or 732B-7001 units. |
| 2 | AC Line Input | IEC-type line cord male connector. All fusing is done in the individual installed 732B units. |

## POWERING THE STANDARD

**3-9.**

The standard must remain powered continuously to maintain the state of calibration. The IN CAL indicator goes out if battery voltage has dropped too low, or if there has been a gross change in oven temperature. Use ac line power at all times unless battery power is required for moving, shipping, or isolating the standard. Leave the BAT switch set to | so it is available to power the standard in case of ac power interruption. Leaving the standard plugged into ac power also maintains full charge on the internal battery.

Switching between line power and battery power has no effect on the standard's output. Variations in ac line voltage within ±10% of the line voltage setting change the 10V output no more than 0.05 ppm. Variations in external dc power within the 12 to 15V range also change the 10V output no more than 0.05 ppm.

When you remove the line power cord from a grounded receptacle, you can use the front panel GROUND binding post to connect the chassis to the same earth ground potential as other instruments in a system.

**3-10.**

### Setting the BAT Switch

**CAUTION**

**To avoid loss of the state of calibration in case of ac power interruption, set the BAT switch to | (on). This enables battery backup power.**

Leave the rear panel BAT switch set to | to enable proper battery charging, and to allow for automatic changeover to battery power in case of ac power interruption or failure.

If you set the BAT switch to O, the 732B requires continuous power from the ac line or an external dc source to operate. The following situations are the only times it is recommended that you set the BAT switch to O:

1. When you replace the battery. (Connect the standard to ac line power before you set the BAT switch to O.)

2. When you want to ship the unit cold (without battery power).

*NOTE*

*The BAT switch O position allows float charging from the internal ac supply but not from an external source.*

For information about how to set the BAT switch on the 732B when you are using an external dc source such as the 732B-7001, refer to "Powering the Standard from a 732B-7001."

### Charging the Internal Battery 3-11.

To completely recharge the internal battery in a 732B or 732B-7001 External Battery, unplug any external dc source from the rear panel, make sure the BAT switch is set to the | position, and plug the unit into ac line power for 24 hours. The charger applies a constant-current charge until the battery is at approximately 90% capacity. During the constant-current charge, the CHARGE indicator is lit. The charger then switches to float-charging mode to complete and maintain the charge on the battery. In float-charging mode, the CHARGE indicator is extinguished.

The charger circuit is designed to charge the internal battery only. Do not attempt to charge an external battery through the rear panel MONITOR/EXT BAT IN connector. Use a separate charger to charge any external batteries, such as the charger inside the 732B-7001 External Battery and Charger.

### Powering the Standard from a 732B-7001 3-12.

You can power the standard using an external battery such as the 732B-7001 External Battery/Charger, or other 12 to 15V dc source that can supply at least 300 mA. You connect the external dc source through the MONITOR/EXT BAT IN connector. Figure 3-7 shows a pinout diagram of the MONITOR/EXT BAT IN connector. Use this method if you need to operate the standard on battery power for a period longer than 72 hours. Or, if the preferred power source is 12 to 15V dc, you can use this method to power the standard permanently.

Leave the 732B BAT the switch set to | to connect the internal and external batteries in parallel. Each battery is protected from high discharge into the other by current-limiting varistor. Set the 732B BAT switch to <att point=15p>o to isolate the internal and external batteries. In this switch position, an external dc source connected to the MONITOR/EXT BAT IN input continues to power the 732B, but is isolated from the 732B's internal battery.

To power the standard using the 732B-7001, proceed as follows. Use a similar procedure for any other 12 to 15V source.

1. Charge the 732B and 732B-7001 for at least 24 hours.
2. Prepare and connect a cable with a 9-pin connector on each end so that the battery output from the 732B-7001 is connected to the external dc input of the 732B DC Standard. Refer to Figures 3-7 and 3-8 for the connector pinouts.
3. Set the 732B-7001 BAT switch to | enable its output.
4. Set the 732B BAT switch to | to connect the batteries in parallel.
5. After you disconnect ac line power to both units, the 732B DC Standard can be powered by battery for at least 130 hours.

## Replacing the Internal Battery 3-13.

If the battery fails to switch from constant-current charging mode to float-charging mode, either the charger is defective or the battery needs replacement. For preventive maintenance, it is recommended that you have the battery replaced every 18-24 months to ensure 72-hour battery backup time. Refer to Section 5 for how to obtain the correct battery type and for the procedure to replace the battery.

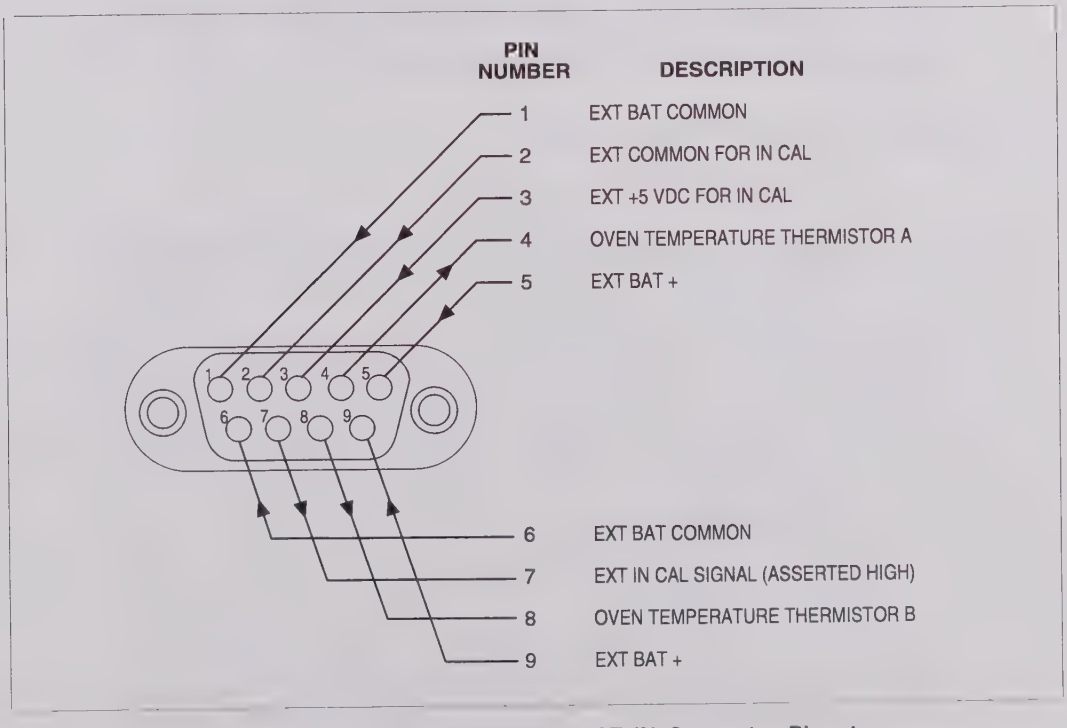


**Figure 3-7. 732B MONITOR/EXT BAT IN Connector Pinout**

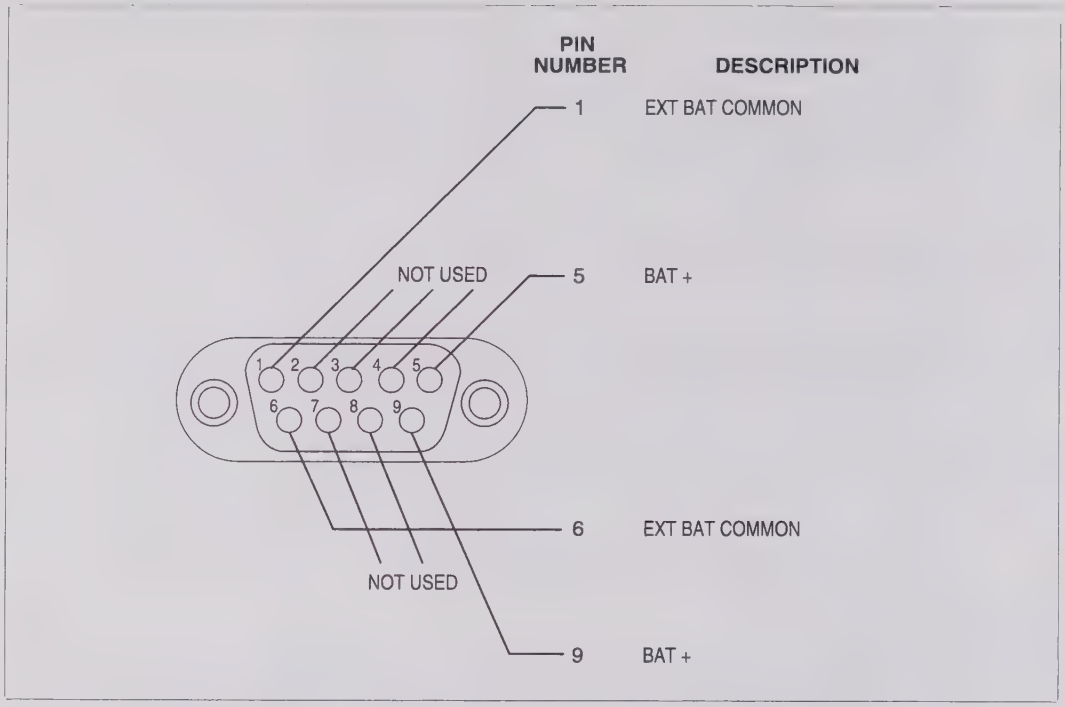


**Figure 3-8. 732B-7001 BAT OUT Connector Pinout**

**WARNING**

**TO AVOID EXPLOSION OR FIRE, BE CAREFUL NOT TO SHORT THE BATTERY TERMINALS DURING BATTERY REPLACEMENT. ONLY QUALIFIED PERSONNEL SHOULD REPLACE THE BATTERY.**

## CONNECTING CABLES TO THE OUTPUT 3-14.

**CAUTION**

**To avoid cracking or jambing the plastic binding post insulators, tighten them only with finger pressure. Do not use tools.**

Shielded test leads should be used for connecting anything to the standard output binding posts. You can use banana plugs, spade lugs, or bare wire to attach cables to the binding posts. The best choice is shielded cables with low-thermal emf connectors such as Fluke Model 5440-7002 Low Thermal Cables. See "Thermal EMFs" further on in this section for more information. Figure 3-9 shows the cable connections for applying the 10V source required by the 5700A during its calibration procedure.

### Connecting the GUARD and GROUND 3-15.

*NOTE*

*Spurious currents in the COM (common) wires will degrade measurements at the accuracy level of the 732B. Make sure the GUARD terminals of all interconnected instruments are tied to earth ground at one point and one point only in the system, and all LO or COM terminals are tied to GUARD at only one point in the system.*

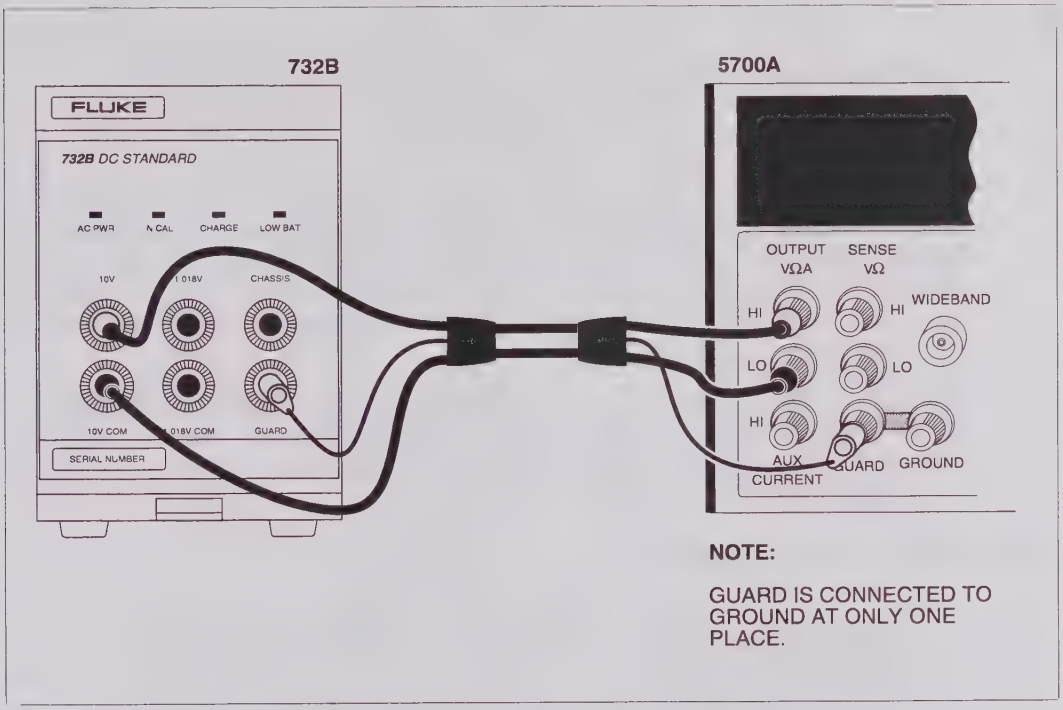


**Figure 3-9. Typical 732B Cable Connections**

Use the GUARD connection when any of the following conditions exists:

1. When a potential exists between equipment and a power line ground.
2. When you use long connection leads to connect a high-impedance load.
3. When you are operating the standard in a high EMI environment.
4. To avoid the effects of electrostatic charge buildup on people.

The GUARD is an electrical shield around the sensitive analog circuitry, insulated from chassis ground and the rest of the standard. The GUARD provides a low-impedance path for common-mode noise and ground currents. The guard eliminates the chance of ground currents in the signal leads caused by plugging the line cord into an ac outlet at a different ground potential than the chassis ground of the interconnected instruments.

Ground currents can occur if instrument guards are not connected properly, resulting in annoying and often subtle measurement errors. The basic rule is, in any system of measurement instruments, the guards within all instruments should be grounded at one and one point only. Circuit common (the 10V COM or 1.018V COM) should be electrically connected to the other instrument guards at one and only one point as well, preferably at the same location the guards are grounded. If an instrument in the system has a grounded input or output, select it as the common earth ground point for all guards in the system.

Figure 3-9 shows a connection to the GUARD binding post. The GUARD is used in that setup to prevent spurious ground currents from degrading the accuracy of the measurement taking place.

*NOTE*

*For best results, connect GUARDS to GROUND in a star configuration. Connect a separate lead between each instrument's GUARD to the common GROUND. Do not connect GUARDS in a daisy-chain configuration.*

With line power disconnected, you can confirm the integrity of your guarding and grounding scheme by checking each instrument with an ohmmeter to find hidden or internal connections between guard, common, and ground. If you have any question about proper guarding and grounding, draw a guarding diagram for your system of instruments, and make sure all instrument guards are tied together and grounded at only one point.

For more information about grounding and guarding, suggested references are Grounding and Shielding Techniques in Instrumentation, by Ralph Morrison, \C1977, John Wiley & Sons; and Noise Reduction Techniques in Electronic Systems, by Henry W. Ott, \C1976, John Wiley & Sons.

## MONITORING OVEN TEMPERATURE 3-16.

As shown in Figure 3-7, MONITOR/EXT BAT IN pins 4 and 8 connect to the two terminals of the oven temperature thermistor. To monitor the oven temperature, measure the resistance between these two pins. The nominal resistance at normal operating temperature is between 36.5 kΩ and 42.5 kΩ. The resistance should change with time by no more than 900Ω per year. The TC (temperature coefficient) of the thermistor is approximately 2 kΩ per °C.

You will be able to use this measurement to gain confidence that oven temperature regulation is working during changes in ambient temperature. Your observations of the thermistor resistance will reveal when the ambient temperature is too extreme for the oven temperature regulation circuitry to work properly.

## RESETTING THE IN CAL INDICATOR 3-17.

If the IN CAL indicator is off, the 732B may not meet its specifications listed in Section 1. The indicator goes off if power to the battery voltage has dropped too low, or if the oven temperature has gone too high or too low. If IN CAL trips off, you will need to recalibrate the 732B, or verify its output before you reset the IN CAL indicator. Refer to Section 5 for the procedure to calibrate the standard and reset the IN CAL indicator.

## MONITORING THE IN CAL INDICATOR STATE REMOTELY 3-18.

As shown in Figure 3-7, three of the MONITOR/EXT BAT IN pins are connection points for monitoring the state of the IN CAL indicator. Figure 3-10 illustrates the IN CAL status output circuit inside the 732B. Proceed as follows to use this connector to remotely monitor the IN CAL indicator:

1. Connect an external +5V logic level to pin 3 (common to pin 2).

2. With a 10 kΩ pullup resistor between pins 3 and 7, monitor the TTL-level signal on pin 7 with respect to pin 2. A high state on pin 7 corresponds to the front panel IN CAL indicator being lit. A low state on pin 7 corresponds to the front panel IN CAL indicator being off.

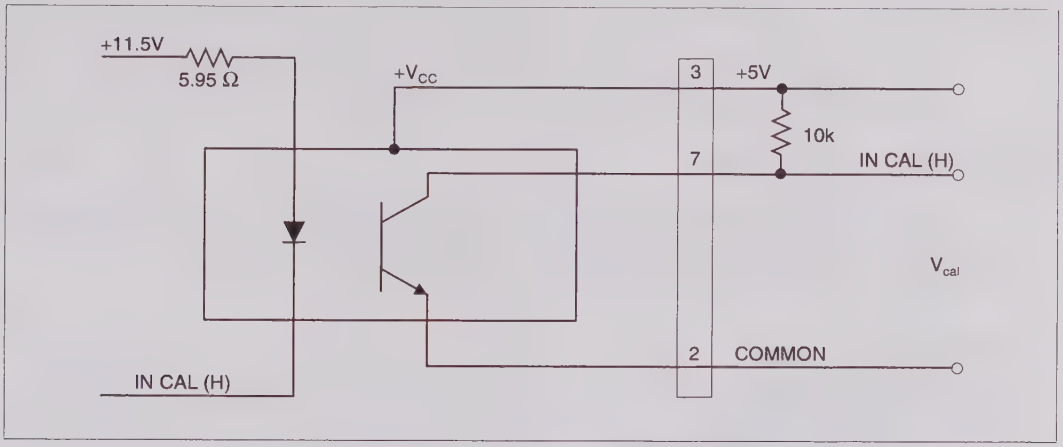


**Figure 3-10. IN CAL Status Output Circuit**

## MONITORING LONG-TERM STABILITY 3-19.

You can determine the long-term stability of the standard by periodically comparing the output voltage to a known reference standard and plotting the difference on a control chart. Output voltage drift, with respect to the legal volt, may be positive or negative and is a characteristic of the individual 732B. Accumulated test data have shown that, once established, the measured drift is generally linear, provided the instrument continues to receive uninterrupted operating power. When drift rate is established, extrapolations of output voltage are possible, and allow certification of the standard with lower uncertainty than is obtainable from the stability specifications alone.

A convenient method of performing the needed periodic calibration is to use the Fluke Direct Voltage Measurement Program, Option 732B-200 (described in Section 1 and the Fluke Catalog), which provides calibration against a traceable reference standard in your own laboratory.

*NOTE*

*A paper has been published that describes a technique for characterizing drift rate of solid state dc voltage references. Refer to "The Fluke Direct Voltage Maintenance Program," by Les Huntley, published in the proceedings of the 1984 Measurement Science Conference.*

Due to the possibility of undetected damage or malfunction, there is a risk involved in relying completely on any single standard. This risk is reduced significantly by using two or more independent standards (with frequent intercomparisons) to ensure that all are stable within the range of expected normal deviations. An added advantage of having multiple, independent standards is the opportunity to use a statistical average of the individual outputs. You can use multiple 732B 10V outputs, as obtained with model 734A, in this way to gain statistical improvements of your standard's uncertainty specification.

## MINIMIZING ERROR SOURCES 3-20.

You can inadvertently defeat the low uncertainty of the 732B output if you do not pay proper care to avoidable error sources. Errors can occur from the effects of thermal emfs, lead and connection resistance, and other sources.

*NOTE*

*Most importantly, always repeat measurements until you are satisfied that the results are repeatable relative to the specification being measured.*

## Mechanically Induced Errors 3-21.

To avoid changing connector contact resistance and degrading the measurement, do not change the stresses on the connectors or cables. Try not to move, jostle, or vibrate the standard or any attached equipment during measurements.

## Thermal EMFs 3-22.

When dissimilar metals at different temperatures come into contact, a thermal voltage is induced. Thermal voltages can exceed 10 μV. All it takes to induce a thermal emf error and adversely affect a measurement is to briefly touch and thereby warm a connector or binding post. Typically, it takes five minutes to thermally stabilize a connection after it has been touched. In addition, use the following techniques to avoid thermal emf errors:

1. Use the Fluke 5440A-7002 Low Thermal EMF Cable Set.
2. Use #24 AWG or larger, bare copper, Teflon\R-insulated connecting wires. It is preferable to use shielded, twisted pair cable. Avoid splices.
3. Avoid the use of ordinary, nickel-plated, banana plugs for equipment interconnections. Use metals that have small thermal emf's with respect to copper.
4. Use low thermal emf copper spade lugs. Crimp the lug onto the wire and solder the connection. Loosen the top of the binding post, insert the lug, and tighten the binding post on the lug with fingers only.

## Output Cable Loading 3-23.

The assigned value of the 10V output is guaranteed *at the binding posts.* A voltage drop in test leads can cause a loading error. Refer to Figure 3-11. In this example, the 1-kΩ load sees a 2 mV degradation of the 10V output. To reduce loading errors in applications where low-impedance loads are unavoidable, use lower resistance test leads (shorter and heavier gauge).

Digital multimeters usually have much higher impedance than 1 kΩ. Most DMMSs have a 10 MΩ input impedance. On the 20V dc range, Fluke 8840A 8505A, and 8506A DMMs present a load impedance higher than 10,000 MΩ. For a DMM with a 10 MΩ input impedance, the loading error would be 0.2 μV. For a DMM with a 10,000 MΩ input impedance, there is no significant loading error.

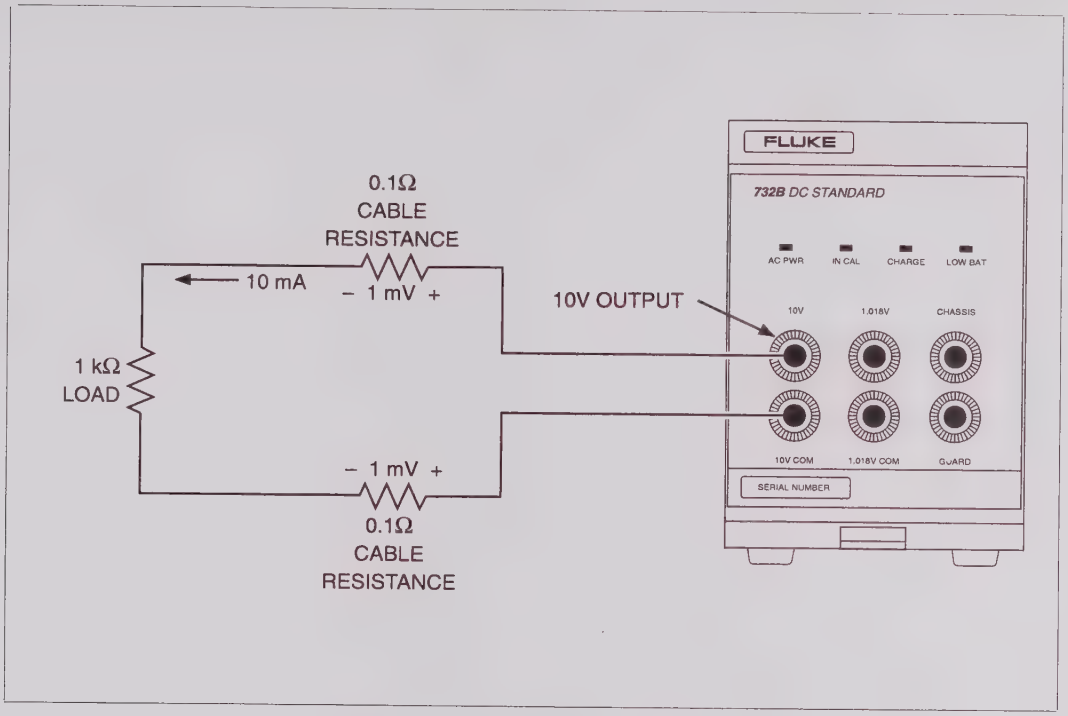


**Figure 3-11. Loading Error Example**

# Chapter 4
# Theory of Operation

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## INTRODUCTION 4-1.

This section presents theory of operation for Models 734A, 732B, and 732B-7001. The section begins with an overall functional description that describes basic theory for each of the three instrument models covered by this manual. The functional description explains how Models 734A and 732B-7001 relate to the 732B DC Standard.

Following the functional description is a detailed circuit description of the Model 732B Standard. An overall 732B block diagram and separate block diagrams for the reference circuitry and battery charger/ac power supply are supplied. Refer to the schematic diagrams for the component-level circuit descriptions.

*NOTE*

*Although theory is provided, no troubleshooting information or parts breakdowns are provided for components and assemblies inside the oven (the small box within the foam insulation). In order to guarantee the output specification, reference assemblies are not repairable. A faulty reference must be replaced as a whole unit. Refer to Section 6 for part number identification and ordering information.*

## OVERALL FUNCTIONAL DESCRIPTION 4-2.

Model 732B is a highly stable 10V, 12 mA dc power supply to be used as a standards laboratory primary dc voltage reference. Refer to Figure 4-1 for an overall block diagram.

The 10V reference circuit can be thought of as a very accurate and stable series regulator that reduces the +11.5V regulated supply voltage to the accurate and stable output available at the front panel 10V and 10V COM binding posts.

The heart of the 10V reference is a pretested, selected reference amplifier (Ref Amp) and a beta string wirewound resistor set. Refer to "732B Circuit Description" for more details. The reference circuit is inside a temperature-controlled oven. The oven temperature controller is a voltage-to-temperature closed loop amplifier. The set point is established by a voltage divider at approximately 6.43V. This 6.43V corresponds to a temperature of 45°C inside the oven.

A precision thermistor mounted close to the reference amplifier on the Reference Hybrid (HR1) substrate enables the user to monitor changes in the oven temperature through the rear panel MONITOR/EXT BAT IN connector. Instructions for using this connector are detailed in Section 3. At an oven temperature of 45°C, the thermistor resistance is approximately 41.3 kΩ.

Four front panel indicators show operating status. The Power Supply (A5 Battery Charger) assembly lights the AC PWR indicator when the 732B is connected to ac line power. The Power Supply also controls the IN CAL indicator to warn that an excessively large drop in 11.5V operating voltage or a large change in oven temperature has occurred.

Another circuit on the Power Supply monitors the battery voltage and controls the LOW BAT indicator. A timer IC on the Front Panel assembly (mounted on the binding posts) serves as an oscillator for LOW BAT causing it to blink.

The dual-mode charger lights the CHARGE indicator when in the constant-current (high-charge) mode. The charger turns off the CHARGE indicator and switches to a float-charge mode when the battery is charged to approximately 90% capacity. The float charge completes and maintains full charge.

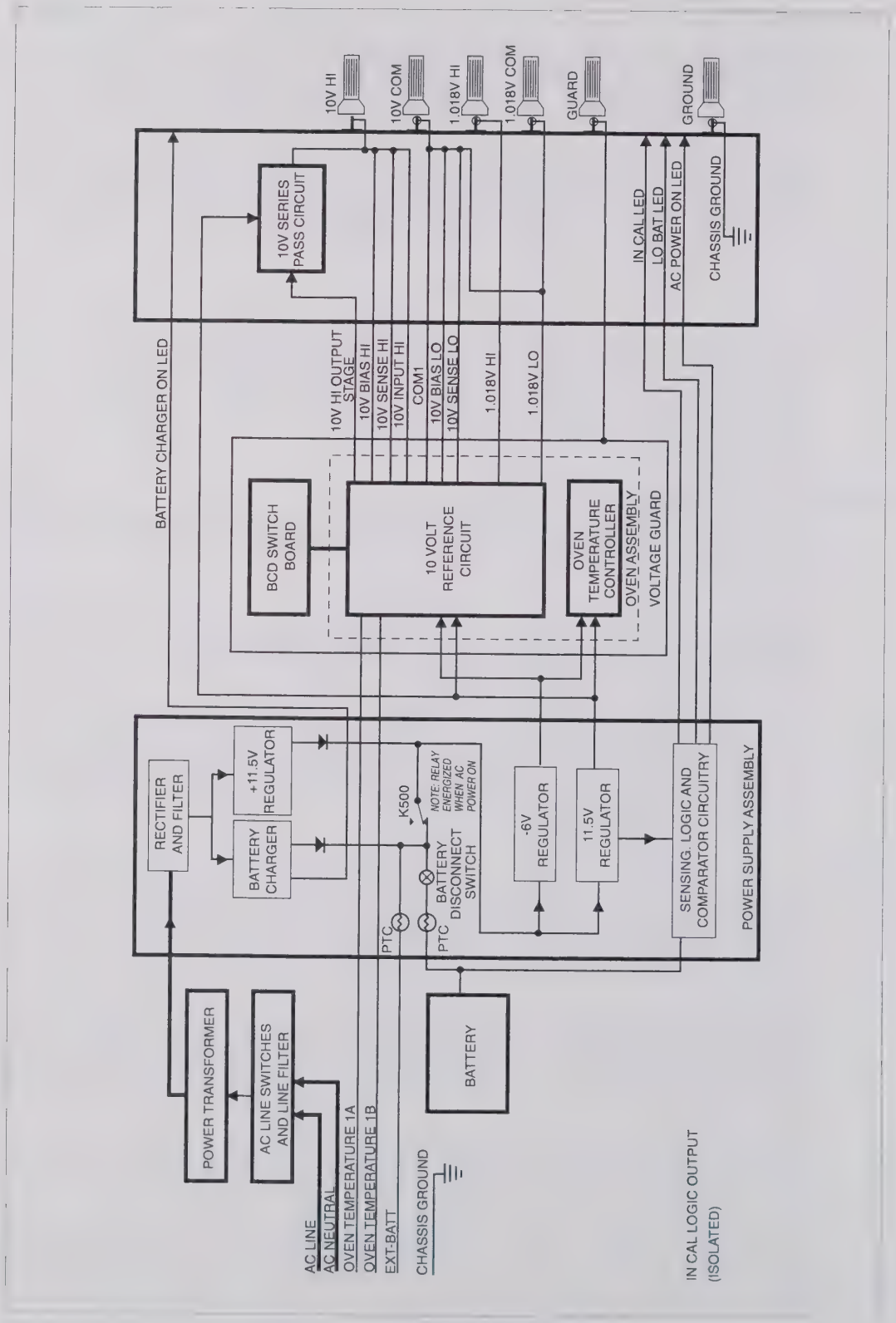



**Figure 4-1. 732B Overall Block Diagram**

Refer to "732B Circuit Description" for a component-level circuit description that begins with the 10V reference circuit and works outward to the oven control and power supply.

## Model 734A Functional Description 4-3.

Model 734A consists of four 732B DC Standards installed in a Model 734A-7001 Instrument Enclosure. The 734A-7001 enclosure contains four internal IEC-type ac line cord connectors and one rear panel IEC-type ac line cord connector. When you slide a 732B or 732B-7001 into one of the instrument bays in the chassis, it automatically connects to the ac power bus. The 734A-7001 Instrument Enclosure provides an ac line power bus only. There is no fuse in the 734A-7001. All fusing and line voltage selection is done in the installed 732Bs and 732B-7001s.

## Model 732B-7001 External Battery/Power Supply 4-4.

Model 732B-7001 is a companion battery and charger for use with the 732B when the there is a requirement for more than 72 hours of portable (battery) operation. The 732B-7001 contains the same battery charger assembly (A5) and gelled-electrolyte sealed lead-acid battery as the 732B. Theory in this section pertaining to the 732B DC Standard's battery charger also applies to Model 732B-7001.

On the 732B-7001, there are no front panel binding posts, and there is no IN CAL indicator. On the rear panel, there is no CAL RESET hole, and the connector labeled MONITOR/EXT BAT IN on the 732B is labeled BAT OUT. For rear panel BAT OUT connector pinout, refer to Figure 3-8 in Section 3.

## 732B CIRCUIT DESCRIPTION 4-5.

Circuits in the 732B are described to the component level in the rest of Section 2 in the following order:

1. 10V Reference Circuit
2. A4 Oven Assembly
3. A5 Power Supplies and Battery Charger
4. A1 Front Panel Assembly

## 10V Reference Circuit 4-6.

Refer to Figure 4-2, the block diagram of the 10V reference circuit. Components that make up the 10V reference circuit are located on the following four assemblies:

- Reference Hybrid (HR1)
- Oven (A4)
- Flex Circuit (A2)
- BCD Switch (A3)

The Reference Amplifier situated on the HR1 hybrid is the most critical part in the 732B because it forms the basis for the 732B's exceptional stability specification. It consists of an NPN transistor in series with a zener diode. When biased properly, the combination has a very low temperature coefficient.

The reference voltage that the Reference Amplifier generates can vary from 6.5V to 7V from device to device. The 10V output will drift in response to the Reference Amplifier voltage drift by the same amount when expressed in ppm. For example, if the Reference Amplifier has a linear drift rate of 0.1 ppm per month, then its effect on the output will be to cause the 10V output to drift 0.1 ppm per month. The Reference Amplifier is located on the Reference Hybrid (HR1) and is identified by the reference designator U4.

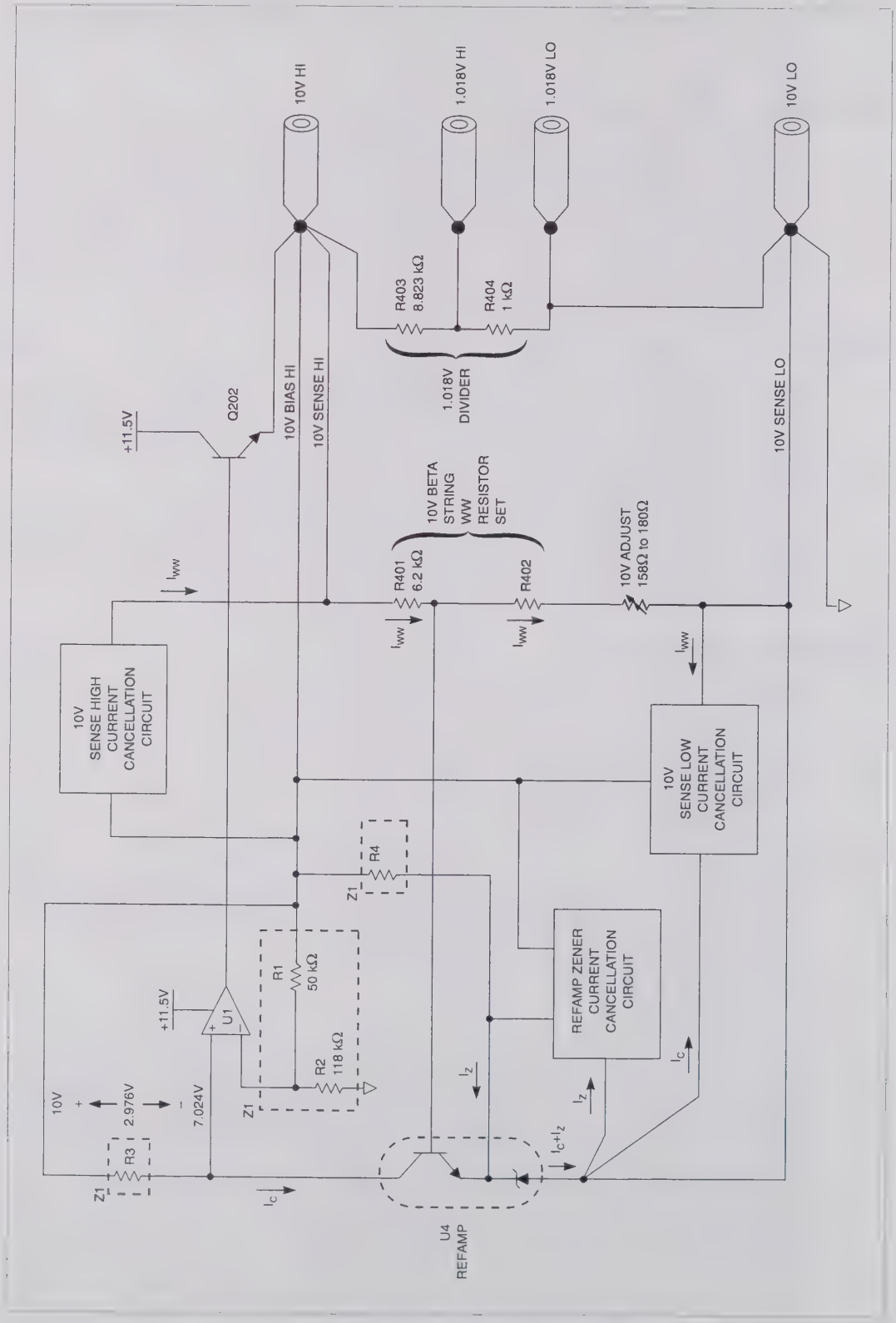



**Figure 4-2. 10V Reference Circuit Block Diagram**

The next major component that is used to generate 10V is the 10V resistor string. This string (R401 and R402) is located on the Oven assembly. These are the feedback elements that set the gain to multiply the reference voltage up to 10V. In its simplest form, the voltage of the 10V output is expressed by the equation $V_o = (V_{ref})(1 + R401/R402)$. The value of R401 is always 6.2 kΩ, and given the value of $V_{ref}$, R402 is wound to the value so that the 10V output equals 10V within ±1 mV.

But because of uncertainties and inaccuracies in these main components, the output voltage can be as much as ±100 ppm (1 mV) from 10V. A high-resolution adjustment circuit compensates for differences in components. Four bcd (binary-coded decimal) switches allow the user to adjust the output in four decade ranges: 0.1, 1, 10, and 100 ppm.

The circuit controlled by the bcd switches is equivalent to an adjustable resistor in series with the 10V feedback string resistor R402. As this adjustable resistor is varied, the effective value of R402 varies, which varies the 10V output. This circuit allows the user to adjust the output with 0.1 ppm resolution over a range of ±220 ppm. The components that make up the 10V adjustment circuit are a thin-film resistor network (Z401 on the Oven assembly), a 180Ω wirewound resistor (R405 on the Oven assembly), and resistors R301 through R306 and SW301 through R304 on the A3 BCD Switch assembly.

## GENERATING THE 1.018V OUTPUT 4-7.

In addition to a 10V output, a 1.018V output is also provided. This output is derived by resistively dividing down the 10V output. The 1.018V output is specified for close to 0 mA (20 pA) current load. The two resistors of this divider are R403 and R404 on the Oven assembly. There is no adjustment of the 1.018V output, except by way of the 10V output adjustment. The 1.108V output is expressed with the equation $V_o = (10V)(R404)/(R403 + R404)$.

## BIASING THE REFAMP FOR LOW TEMPERATURE COEFFICIENT 4-8.

As mentioned earlier, the Reference Amplifier contains an NPN transistor and a zener diode in series. The TC (Temperature Coefficient) of the Reference Amplifier is the sum of the TC of the zener voltage and the transistor base-emitter voltage. The zener voltage TC is negative and the transistor TC is positive with a value dependent on its collector current. Each Reference Amplifier is pretested to determine the collector current at which the two TCs cancel out yielding an overall Reference Amplifier TC very close to zero.

To generate this same collector current in the standard, a voltage of 2.976V is generated across thin film resistor Z1-R3 on the Reference Hybrid (HR1). This resistor is pretrimmed with a laser to the value that results in the correct collector current.

## SENSE CURRENT CANCELLATION 4-9.

The purpose of the current cancellation circuits is to source current to or sink current from components that are referenced to 10V sense low or connected to 10V sense high. In the absence of the current cancellation circuits, bias current from these components would flow through the 10V sense high and low lines to return to the power supply common, degrading the performance of the 10V circuit.

Three different sense current cancellation circuits are used:

1. 10V sense high current cancellation circuit
2. 10V sense low current cancellation circuit
3. Reference Amplifier zener current cancellation circuit

The first circuit (U3A, R2, R3, VR2, and Z1-R10 on the reference hybrid) supplies current to the 10V high side of the 10V beta string resistors. The second circuit (U2B, R8, R9, and Z1-R8 Z1-R9) sinks current from the 10V low side of the 10V beta string resistors and Reference Amplifier collector current. The third circuit (U2A, Z1-R5 through Z1-R7, R5, and R6 on the reference hybrid) sinks the current from the anode of the Reference Amplifier zener. Thin film resistors Z1-R8 through Z1-R10) are laser trimmed to values that are a function of the Reference Amplifier voltage and collector current.

### BUFFERING OF THE 10V OUTPUT 4-10.

The 10V high output stage contains the series-pass components that supply load current to the binding posts and bias current to the Reference Amplifier, and other critical circuitry inside the ovenized assembly. The 10V high output stage also contains an output current-limit circuit that prevents loads from drawing more than 12 mA. Components for the 10V high output stage are located on the Flex assembly and include Q201 and Q202, C201 through C204, R201, and CR201.

### Oven Temperature Controller A4 4-11.

The oven temperature controller is a voltage-to-temperature closed loop amplifier. The set point is established by a voltage divider on Z401. The set point voltage is approximately 6.43V. This corresponds to a temperature of 45°C inside the oven.

U401B serves as a summing junction and amplifier. The setpoint divider, the feedback thermistor on HR3, and a gain resistor on Z401 form a bridge that is insensitive to changes in Vcc when the bridge is balanced or close to being balanced.

The feedback element is a precision, stable NTC thermistor. The stability of this element is critical to the stability of the oven temperature.

U401A acts as a voltage amplifier with a gain of 240. The output of this amplifier feeds a common-emitter stage where the emitter resistors are the heaters. Q401 is the control transistor for the heaters and its power dissipation also adds to the power that the heaters produce.

To provide good thermal coupling, the feedback thermistor is mounted on the back side of one of the heater substrates, HR3.

RT401 and R412 serve as a temperature sensitive voltage divider that provides a voltage signal, TEMP-SENSE, that feeds the IN CAL LED logic.

A precision thermistor mounted close to the Reference Amplifier on the Reference Amplifier substrate enables the user to monitor oven temperature through the MONITOR/EXT BAT IN connector on the rear panel. (Figure 3-7 shows the connector pinout.) At an oven temperature of 45°C, the thermistor resistance is approximately 41.3 kΩ.

### A1 Front Panel assembly 4-12.

The Front Panel assembly contains the following two functional blocks:

1. LED Circuitry
2. Overvoltage Protection Components

The LED Circuitry includes the LEDs and the drive circuitry for the following front panel indicators:

- AC PWR: When lit, this indicates that ac line power is applied to the 732B.
- CHARGE: When lit, this indicates that the battery charger is in the constant current mode (high level charging) as opposed to the float charge mode.
- IN CAL: Normally lit. This indicator tells the user that the standard oven temperature is within the limits of 35°C to 55°C and that operating power has not been interrupted.
- LOW BAT: Normally off. It blinks at a 1 Hz rate when the battery voltage drops below +11.4V, indicating that the user should immediately plug the standard into ac line power to begin recharging the battery.

The overvoltage protection circuitry consists of power diode CR104 and "Transzorb" transient suppressor device VR101. These components are connected between the 10V and 10V COM terminals and protect the 732B internal circuitry from external application of voltages higher than 12V. Another layer of protection is provided by a spark gap from the 10V COM binding post to chassis ground.

The LED circuitry is composed of CR100 through CR103, R100 through R103, U100, Q100, C100 through C101, and R104 through R106. CR100 through CR103 are the front panel LEDs. R100 through R103 serve to limit the current through the LEDs. U100, C100 through C101, and R104 are a 1-Hz oscillator for blinking CR103 (LOW BAT). Resistors R105 through R106 and Transistor Q100 are used as an inverting switch to start and stop the oscillator.

## Power Supplies and Battery Charger Assembly A5 4-13.

Refer to Figure 4-3 and the A5 schematic diagram in Section 7 for the following discussion. The Power Supply Module (A5) contains several functional circuit groups as listed below:

1. Overvoltage Protection Circuitry
2. Raw DC Power Supply
3. Battery Charger
4. +11.5V Preregulator
5. +11.5V Low-Dropout Regulator
6. -6V Power Supply
7. IN-CAL Logic
8. LED Drive Circuitry
9. AC to Battery Switching Circuit
10. Battery Circuit
11. Rear Panel Connections

### OVERVOLTAGE PROTECTION CIRCUITRY 4-14.

The 732B has overvoltage protection circuitry in the event that the user has the ac voltage select switch set for 100V ac or 120V ac and connects the ac input lines to 180V ac or greater. In this case, there is circuitry to short the secondary of the transformer and blow the main fuse in the Line Filter assembly, FL1.

The transformer secondary voltage is first rectified by diodes CR513 through CR516, and the rectified ac is applied to both CR500 and the series divider composed of VR501, R500 and R501. If the voltage applied is greater than 43V, then VR501 conducts and the resulting current causes a voltage across R501 which then gates CR500 to the conducting state. This shorts out the secondary and blows the primary fuse in the ac filter assembly FL1. R500, R501, and C500 act as a noise filter to prevent inadvertent gating of CR500. R500 also acts as a current limiter for VR501.

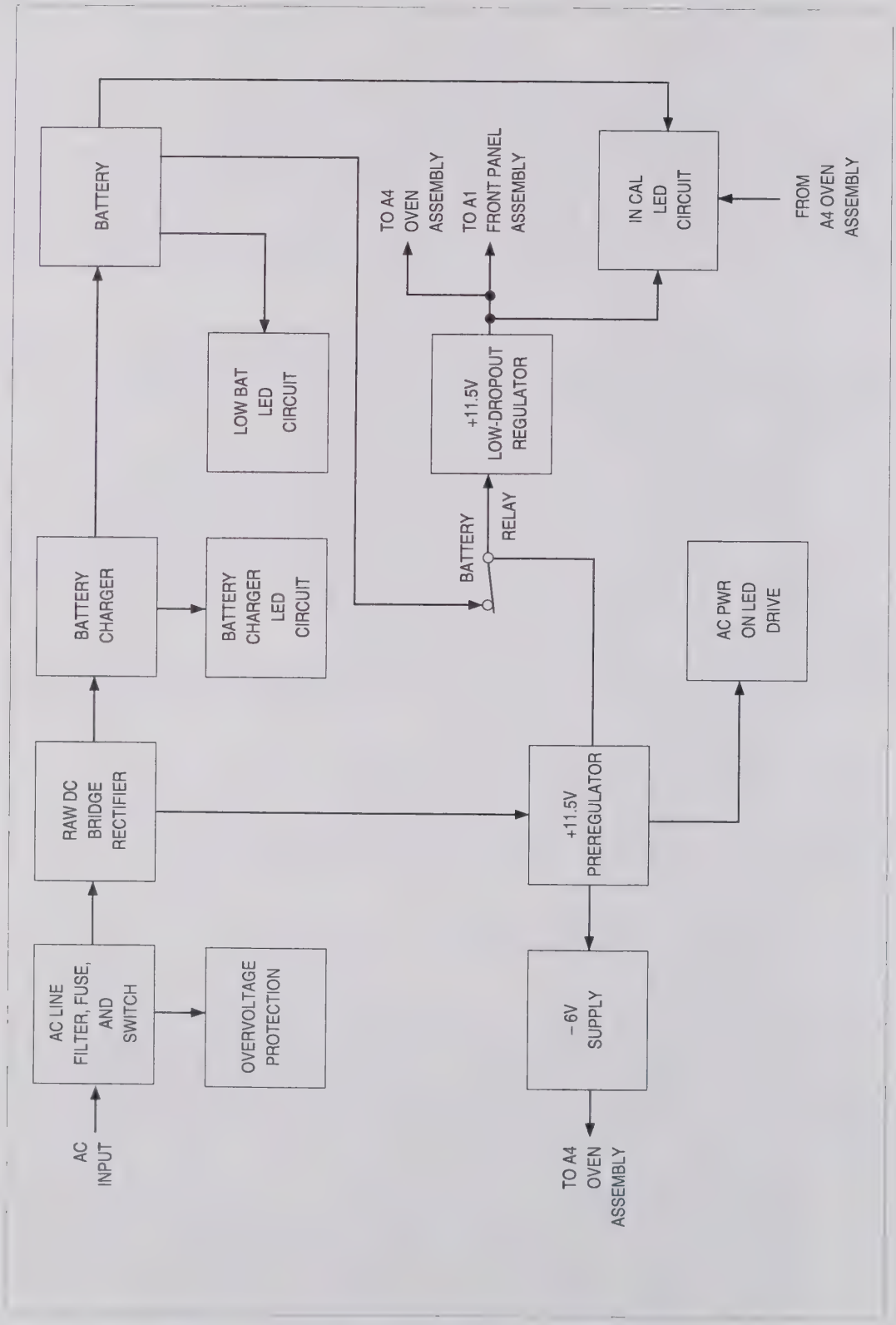



**Figure 4-3. A5 Power Supply/Battery Charger Block Diagram**

## RAW DC POWER SUPPLY

4-15.

The basic components of this circuitry are the bridge rectifier composed of CR501 through CR504, capacitor C502, and voltage regulators U500 and U504. The bridge rectifies secondary ac from the transformer. Capacitor C502 then filters the voltage to provide raw dc at the input of the three-terminal regulators U500 and U504. Resistor R558 acts as a bleeder resistor for C502. C504 and C514 provide local decoupling for U500 and U504 respectively.

## BATTERY CHARGER

4-16.

The battery charger for the 732B is a dual mode charger. The charger operates as a constant current source for a fast charge until the battery is approximately 90% charged. Then the charger circuitry switches to a voltage source for the remainder of the charge and for a float charge.

Regulator U500 is the central element of the battery charger. When the battery voltage is below 12V, Q502 is turned off and the U500 circuitry forms a current source controlled by the value of the parallel resistance of R502 and R503. This is set to charge at a nominal rate of 234 mA. As the battery charges, the internal impedance of the battery remains relatively constant until it is about 90% charged. At this point, the internal impedance starts increasing rapidly, and the voltage of the current source also starts to increase rapidly. This provides the sense point for a mode switch.

Resistors R520 and R521 form a voltage divider for a comparator formed by U501 and R517 through R519. When the voltage exceeds 15.3V at the battery terminals, the comparator switches states and turns Q502 on. This converts the U500 circuitry to a voltage source with a source impedance that reduces the voltage out as the current draw increases. Thus, when the charger first switches from constant current to voltage, the charge current is typically 10 to 75 mA, and gradually reduces to typically 5 to 15 mA when the battery is fully charged. Resistor R518 provides hysteresis in the comparator. Thus, the comparator doesn't switch from the float mode back to the constant current mode until the battery voltage drops below 12.0V. The comparator switches according to the following:

- Constant I to Float Voltage at 15.3V
- Float Voltage to Constant I at 12.0V

## +11.5V PREREGULATOR

4-17.

The +11.5V power supply is composed of two regulators. The first is the +11.5V Preregulator that converts the raw dc into +14.9V nominal. The second regulator converts this +14.9V or the battery voltage into a precisely controlled +11.5V for the 10V reference circuitry.

The +11.5V Preregulator consists of U504, C514, CR507, CR508, C515, R531, R532, and C529. The output voltage of adjustable regulator U504 is set by the values of R531 and R532. Capacitor C514 provides local decoupling, CR507 and CR508 protect the regulator IC (U504), C515 provides ripple rejection, and C529 stabilizes the regulator loop.

## +11.5V LOW-DROPOUT REGULATOR 4-18.

The Low-Dropout Regulator provides an accurate +11.5V to the Reference Amplifier and Oven Temperature Control circuitry inside the oven. To maximize the battery life of the standard, it is necessary to have the least voltage drop possible between the battery and the oven circuitry.

The central component in this circuit is Q504. This is a MOSFET power IC with a drain-to-source resistance (when turned on) of approximately 0.3Ω. Thus, with the maximum oven current of approximately 120 mA, the voltage drop of the regulator is less than 0.04V with the regulator fully on. Transistor Q504 acts as the series-pass element of the regulator.

IC U505 provides a precision +10V for the reference of the regulator. U506 is the error amplifier. Resistors R538 and R539 set the regulated output voltage at 11.5V.

## -6V POWER SUPPLY 4-19.

The -6V power supply is used for the current cancellation circuit in the Reference Amplifier and for the Oven Temperature Control circuit. Both of these are inside the oven.

IC U511 is the central component in the -6V supply. U511 is a switched capacitor voltage converter with regulator. R552 and R553 in combination with the internal reference of the IC set the output voltage level.

## IN CAL LOGIC 4-20.

The 732B has an indicator on the front panel for IN CAL. This indicates that the oven temperature has remained between 35 and 55°C and that the voltage measured at the battery has not been reduced below 11.2V dc. If the oven temperature is between 35 and 55°C, pressing the rear panel CAL RESET switch resets (lights) the IN CAL indicator.

The IN CAL indicator stays lit unless the oven temperature drifts out of the 35 to 55°C range, or if battery voltage drops too low. This mechanism monitors for defects in the oven control, and warns the user when the standard is not considered to be in calibration.

Two comparator circuits determine if the oven temperature is in the proper range. A thermistor and resistor in a voltage-divider configuration sense oven temperature. (See the Oven Control theory for more details.) The output of this divider is fed to comparators U507C and U507D. Comparator U507C is set to trip when $T_{oven}$ is over 55°C. Comparator U507D is set to trip when $T_{oven}$ is below 35°C.

These two comparators are in a wired-OR configuration with U507B, which detects low 11.5V voltage at the battery. This wired-OR goes to a resettable latch circuit made up of NAND gates U509.

## LED DRIVE LOGIC 4-21.

In addition to the IN CAL indicator, there are three other indicators on the front panel:

- AC PWR
- CHARGE
- LOW BAT

The AC PWR LED is controlled by the voltage at the ADJUST pin of U504. If ac line power is applied to the standard, there will be approximately 13.5V at the ADJ pin of U504. This is applied to Q507, which switches voltage to the AC PWR LED.

The CHARGE LED is driven by an inverting amplifier Q505. There is an effective AND function with the ac power and the battery charger mode as follows:

1. If the charger is in the constant current mode, Q502 is biased off.
2. If ac line power is applied to the standard, the voltage at the collector of Q502 is high (approximately the battery charge voltage), Q505 is ON and the LED is energized, indicating that the battery charger is in the constant current mode or high charge rate mode. If there is a mode change or if the ac line power is removed, the LED goes out.

The LOW BAT LED is controlled by a comparator off the battery terminals. This comparator senses the voltage of the battery and if the voltage drops below 11.3V, the LED will begin blinking at a 1-Hz rate. The oscillator circuitry is on the front panel assembly. The circuitry on the power supply assembly simply turns the oscillator on or off. The comparator has hysteresis in it such that the comparator "sets" at 11.3V and "resets" at 11.7V.

## AC POWER TO BATTERY POWER SWITCHING CIRCUITRY 4-22.

If the rear panel BAT switch is set to |, and ac line power is removed from the 732B, the battery is connected to the Low-Dropout Regulator to provide uninterrupted power for the +11.5V supply.

The switching circuitry is composed of relay K500, VR502, and Q503. Under normal ac line operation, K500 is energized and the battery is isolated from the Low-Dropout Regulator. As the voltage across VR502 and R534 falls below 13V, VR502 stops conducting and Q503 turns off. K500 de-energizes, and the battery voltage is applied to the Low-Dropout Regulator.

## BATTERY CIRCUIT 4-23.

The battery is a 12V 6.5 amp-hour sealed lead acid battery. If the battery is fully charged, it provides at least 72 hours of standard operation (with 10V output current limited to <=0.1 mA) at an ambient temperature of 25°C. The battery is connected to the power supply assembly by a two-wire cable. There is protection for the battery in the form of a diode, CR517, and PTC thermistors RT502 (for an external battery) and RT503 (for the internal battery).

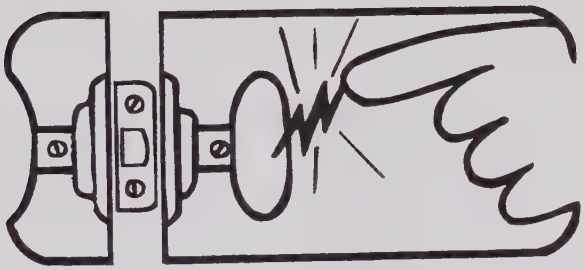
The diode protects the circuitry on the power supply assembly in case the battery leads are mistakenly reversed. If the leads are reversed, the diode conducts, keeping the voltage between +12V-BATT and Common to around 0.7V. At the same time, the current through the PTC thermistor RT503 heats up the thermistor and serves as a current limit. RT502 serves the same purpose for an externally connected battery. Switch SW502 disconnects the battery for shipping the standard cold (with operating power turned off).

## REAR PANEL CONNECTIONS 4-24.

There are several input and output connections on the rear panel of the 732B. The most obvious are the ac line power and GROUND inputs. The rear panel also has an access hole for actuating the CAL RESET switch and a 9-pin connector labeled MONITOR/EXT BAT IN. The connector provides for attaching an external battery or other 12 to 15V dc source, for monitoring the oven temperature, and for remotely monitoring the IN CAL indicator status. See Figure 3-7 for its pinout. Figure 3-8 shows the pinout for the rear panel BAT OUT connector on the 732B-7001.

# static awareness

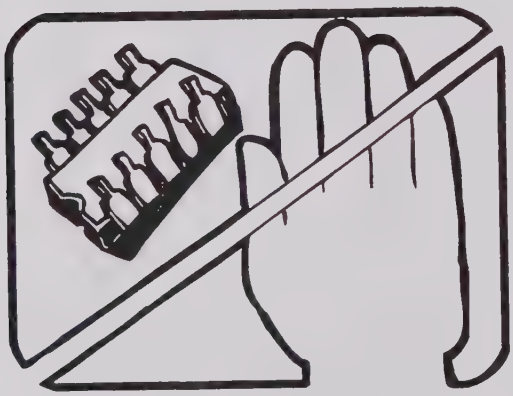
**A Message From**
**Fluke Corporation**



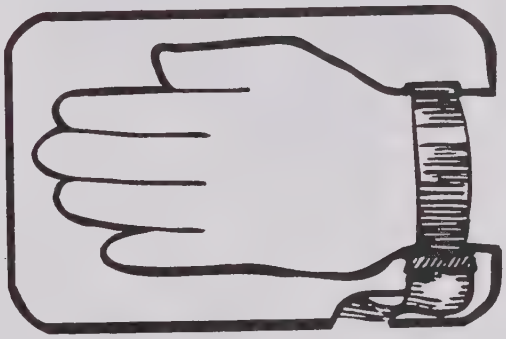
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Leaning the guidelines for handling them.
3. Using the procedures, packaging, and bench techniques that are recommended.

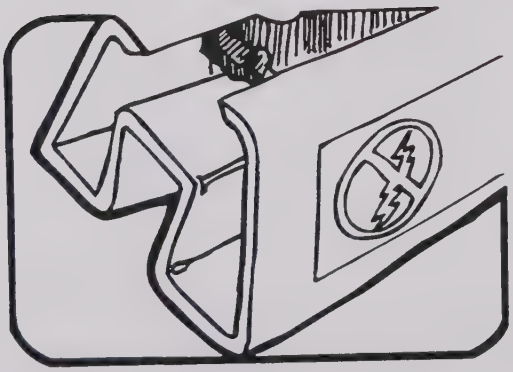
The following practices should be followed to minimize damage to S.S. (static sensitive) devices.



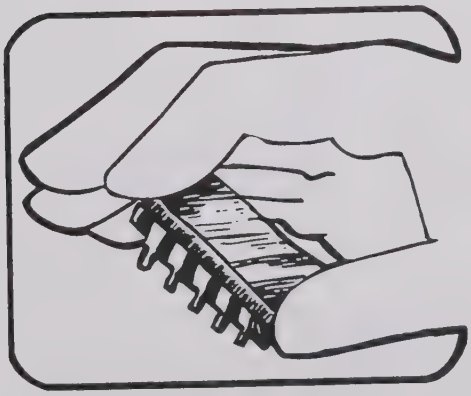
1. MINIMIZE HANDLING



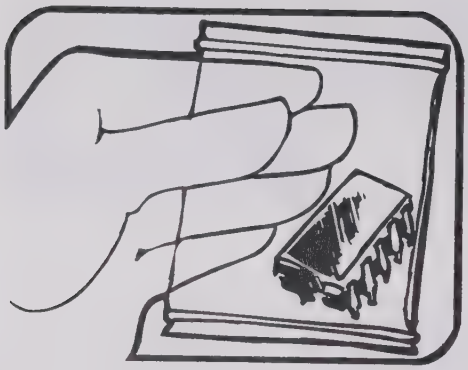
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



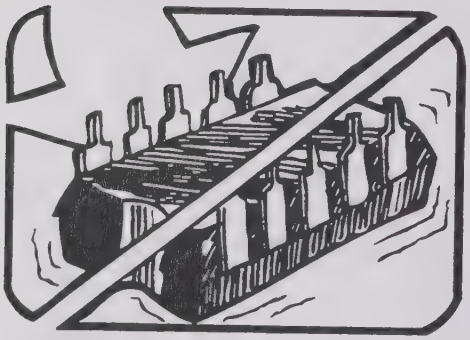
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



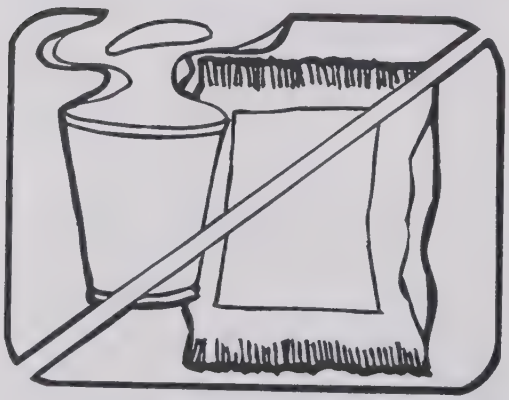
4. HANDLE S.S. DEVICES BY THE BODY.



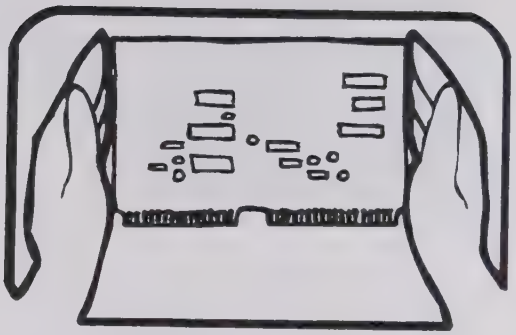
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT.



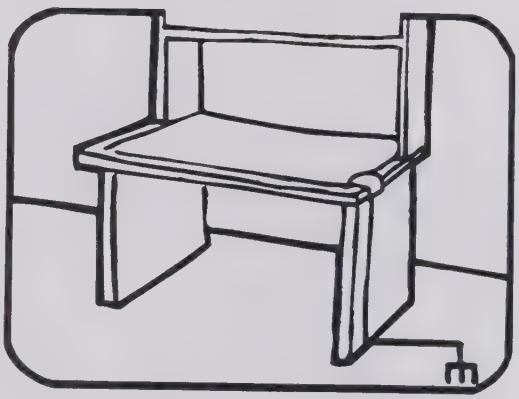
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE.



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA.



8. WHEN REMOVING PLUG-IN ASSEMBLIES HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS PROTECT INSTALLED S.S. DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION.

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED-TIP SOLDERING IRONS SHOULD BE USED.

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# Chapter 5
# Maintenance

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**WARNING**

**SERVICING DESCRIBED IN THIS SECTION IS TO BE DONE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK OR FIRE, DO NOT SERVICE THE 732B UNLESS YOU ARE QUALIFIED TO DO SO.**

## INTRODUCTION 5-1.

This section explains how to calibrate the 732B and how to do other maintenance tasks. You can also return the 732B to Fluke for recalibration and certification of traceability to NIST (National Institute of Standards and Technology, formerly NBS). (See Section 1 for the procedure to obtain service or calibration from Fluke.)

## SERVICE INFORMATION 5-2.

The 732B is warranted for a period of 1 year on delivery to the original purchaser. The Warranty is located on the reverse side of the title page at the front of this manual.

Factory authorized calibration and service for Fluke products is offered at various worldwide locations. A list of Fluke Service Centers is located at the end of the parts lists in Section 6. Refer to Section 1 for shipping information.

## REPLACING THE FUSE 5-3.

Refer to Section 2 for the fuse access procedure.

## CLEANING THE EXTERNAL SURFACES 5-4.

**CAUTION**

**To prevent possible damage to the surfaces of the standard, do not use aromatic hydrocarbons or chlorinated solvents for cleaning.**

When the 732B is properly cared for and kept in a controlled atmosphere, you seldom need to clean it. However, any contamination, particularly oil, on the instrument can create leakage paths that can degrade accuracy.

To keep the standard looking like new, clean the case with a soft cloth slightly dampened with water or a non-abrasive mild cleaning solution that does not harm painted surfaces or plastics. Do not attempt to clean the interior of the instrument.

## CALIBRATION 5-5.

If the IN CAL indicator is off, or if your calibration interval is expiring, use one of the following procedures to calibrate (assign a value to) the 732B. After you complete calibration, reset the IN CAL indicator as described further on in this section.

To maintain its status as a traceable standard following calibration, the 732B must continue to receive uninterrupted operating voltage from the ac line or from the internal battery. If operating power is interrupted, the front panel IN CAL indicator goes off and recalibration is necessary.

You have a choice of two 10V output calibration procedures. Both procedures use direct comparison between your 732B, called the Unit Under Test (UUT), and a certified 732B or 732A to calibrate the 10V output. In the first procedure, you do not adjust the 732B under test. In the second procedure, you adjust the 10V output of the 732B under test so that it is equal to the reference standard. The 1.018V output is divided down from the 10V output, and is not independently adjustable.

*NOTE*

*Equivalent equipment and methods may be substituted for the following calibration procedures as long as the equipment and standards used are at least as accurate as those specified.*

## Preparing for Calibration 5-6.

Choose either the procedure with adjustment or without adjustment. Table 5-1 lists the equipment you will need to calibrate the 732B. Before you proceed, leave the 732B powered on with the BAT switch set to I and the standard plugged into ac line power for 24 hours. This stabilizes the oven temperature and fully charges the internal battery. Just before you begin, disconnect the ac line cord to change to battery power. If you want to calibrate the 732B without adjusting it, skip to "10V Calibration Without Adjustment."

## Preparing for 10V Calibration with Adjustment 5-7.

In this method, you to adjust the 10V output of the 732B during the calibration procedure. To access the bcd adjustment switches, perform the "Initial Access Procedure" in this section. The bcd output adjustment switches are located on top near the front of the instrument as shown in Figure 5-2. Each switch has the numbers 0 through 9 marked on it. Each higher numbered switch setting causes the output voltage to increment a positive amount.

The switches are labeled to represent the approximate 10V output shift in ppm as follows:

- Switch "100" (ppm) adjusts the output in increments of approximately 1 mV to 1.5 mV. The usable range of this switch is 0 to 3. Positions greater than 3 are not implemented and will simply repeat positions 0 through 3.
- Switch "10" (ppm) adjust the output in increments of approximately 100 µV to 150 µV. The usable range of this switch is 0 to 9.
- Switch "1.0" (ppm) adjusts the output in increments of approximately 10 to 15 µV. The usable range of this switch is 0 to 9.
- Switch "0.1" (ppm) adjusts the output in increments of approximately 1 µV. The usable range of this switch is 0 to 9.

**Table 5-1. Equipment Required for Calibration**

| EQUIPMENT | MANUFACTURER AND MODEL | MINIMUM USE SPECIFICATIONS |
|---|---|---|
| Null Detector | Fluke 845A or B | 0.1 µV Resolution |
| Low Thermal Shielded Test Leads | Any | N/A |
| Calibrated 10V Reference Standard | Fluke 732B or 732A | Certified to the uncertainty required for your laboratory |

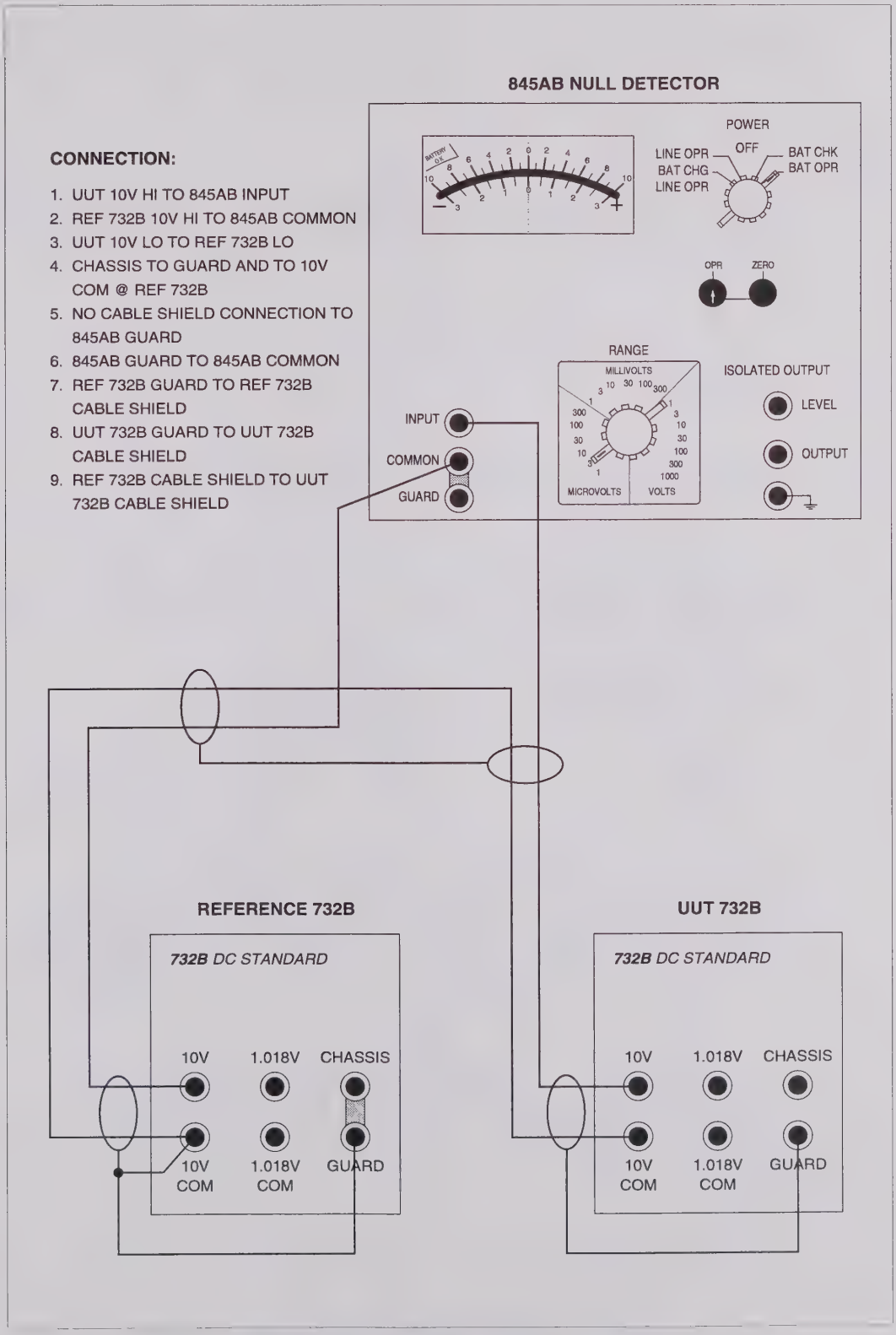


**Figure 5-1. 10V Output Calibration Connections**

The lowest bcd switch setting is "0000" and the highest is "3999" (in the most significant to least significant bit order). This range of settings represents total adjustment of 400 ppm (4 mV) minimum, with a resolution of approximately 1 μV. Typically, the bcd setting for an exact 10.0V will range from 1400 to 2200.

## Calibration with Adjustment 5-8.

Complete the following procedure to standardize the output of the 732B to a Certified 732B. Verify that for the UUT, the 24-hour warmup period on ac line power has been met. Operate the UUT 732B and 845A/B on battery power. Always set the null detector to ZERO when changing leads.

Proceed as follows to calibrate the 732B:

1. Obtain a certified 732B or 732A to use as the reference standard.

**CAUTION**

**To avoid cracking or jambing the plastic binding post insulators, tighten them only with finger pressure. Do not use tools.**

2. Connect the UUT, certified 732B, and null detector as shown in Figure 5-1.

3. Set the OPR switch on the null detector to the ZERO position. Adjust the null detector for zero on the 3 μV range.

4. Set the null detector to the 30 μV range and the OPR switch to OPR. If the null detector needle is pegged, set the range to 100 μV.

5. Adjust the 1.0 ppm bcd switch until the null detector reads less than 10 μV positive or negative.

*NOTE*

*If the switch reaches "0" and the null detector is more positive than 10 μV, adjust the 10 ppm bcd switch down one setting. If the 10 ppm bcd switch is already at "0", adjust the 100 ppm switch down one setting and set the 10 ppm bcd switch to "9". Continue adjusting the 1.0 ppm bcd switch until the null detector is within 10 μV.*

*NOTE*

*If the switch reaches "9" and the null detector is more negative than -10 μV, adjust the 10 ppm bcd switch up one setting. If the 10 ppm bcd switch is already at "9", adjust the 100 ppm switch up one setting and set the 10 ppm bcd switch to "0". Continue adjusting the 1.0 ppm bcd switch until the null detector is within 10 μV.*

6. Set the null detector to the 10 μV range and adjust the 0.1 ppm bcd switch until the null detector reads less than 3 μV, positive or negative.

7. Set the null detector to the 3 μV range. Set the OPR switch on the Null Detector to the ZERO position. Readjust the null detector for zero, if necessary.

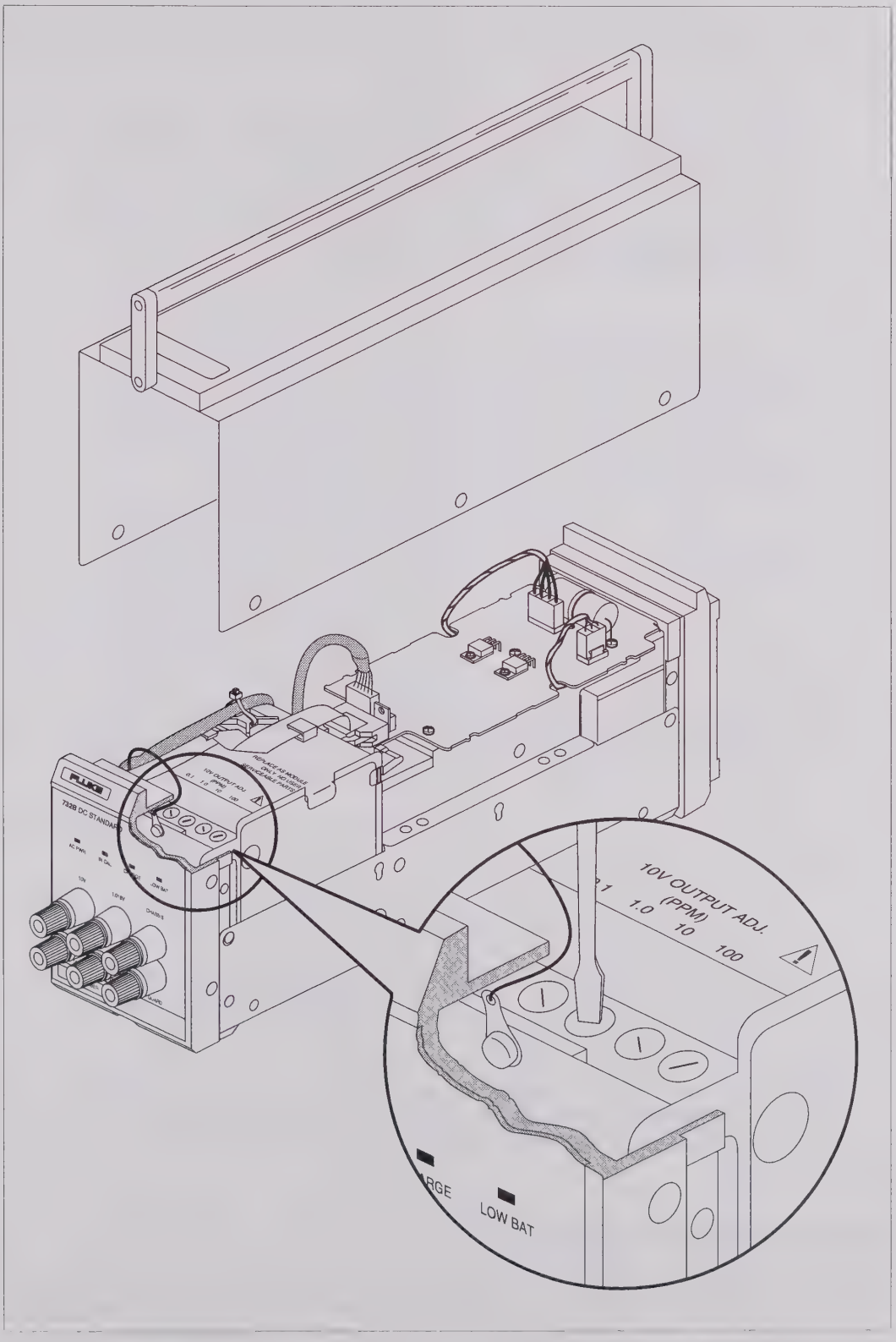


**Figure 5-2. Location of 732B Calibration Adjustment Switches**

8. Allow the system to stabilize for at least one minute before final adjustment. Adjust the 0.1 ppm bcd switch for a null indication on the null detector.

*NOTE*

*If the switch reaches "0" and the null detector is still on the positive side of a null, adjust the 1.0 ppm bcd switch down one setting. If the 1.0 ppm bcd switch is already at "0", adjust the 10 ppm switch down one setting and set the 1.0 ppm bcd switch to "9". Continue adjusting the 0.1 ppm bcd switch for a null indication on the null detector.*

*NOTE*

*If the switch reaches "9" and the null detector is still on the negative side of a null, adjust the 1.0 ppm bcd switch up one setting. If the 1.0 ppm bcd switch is already at "9", adjust the 10 ppm switch up one setting and set the 1.0 ppm bcd switch to "0". Continue adjusting the 0.1 ppm bcd switch for a null indication on the null detector.*

9. Reverse the HI and LO (positive and negative) leads on the UUT and certified 732B.

10. Set the OPR switch on the null detector to the OPR position and observe the reading. If the reading does not equal zero, adjust the UUT for one-half of the null detector reading.

11. Reverse the HI and LO (positive and negative) leads on the UUT and on the Certified 732B. The null detector should have the same reading as it did at the end of step 10. If it does not, adjust the UUT for one-half the difference.

12. Repeat steps 9 through 11 until the Null reading does not change when the UUT and Certified 732B leads are reversed.

13. The residual reading on the null detector equals the sum of the thermal voltages in the circuit. At this point, the output voltage of the UUT equals the output voltage of the Certified 732B.

14. If the IN CAL led is illuminated, proceed to step 15. If it is not, depress the switch inside the RESET hole located on the rear panel.

15. Calibration on the 10V output is complete. Record all test results. Disconnect all test equipment. Place the top cover on the UUT, securing it with the six screws. Cover the RESET hole and one of the six screws with tamper-proof calibration seals.

## Calibration Without Adjustment 5-9.

Complete the following procedure to standardize the output of the 732B to a Certified 732B. Battery operation of the 732B UUT is preferred. Turn on the filtering of the 8506A.

1. Obtain a certified 732B or 732A to use as the reference standard.

**CAUTION**

**To avoid cracking or jambing the plastic binding post insulators, tighten them only with finger pressure. Do not use tools.**

2. Connect the UUT, Certified 732B, and 8506A as shown in Figure 5-1. (Substitute the 8506A for the 854AB shown in the figure.)
3. Average 8506A readings over a period of at least one minute.
4. Reverse the HI and LO (positive and negative) leads on the UUT and certified 732B.
5. Average 8506A readings over a period of at least one minute.
6. Subtract the reading in step 5 from the reading in step 3 and divide this difference by 2.
7. To determine the 10V value of the 732B UUT, add the value in step 6 to the 10V value of the reference.
8. If the IN CAL led is illuminated, proceed to step 9. If it is not, depress the switch inside the RESET hole located on the rear panel.
9. Calibration of the 10V output is complete. Record all test results. Disconnect all test equipment. Place the top cover on the UUT, securing it with the six screws. Cover the RESET hole and one of the six screws with tamper-proof calibration seals.

## ACCESS PROCEDURES 5-10.

Procedures to access the battery, the oven assembly, the A5 Battery Charger/Power Supply, and the power transformer follow. No access procedure is provided for components and assemblies inside the oven assembly. The oven assembly contains no user-serviceable parts, and must be replaced as a unit in case of failure. This unit is the small box inside the foam insulation, and it includes the attached flex circuit.

### Initial Access Procedure 5-11.

Refer to Figure 5-3 and proceed as follows to remove the 732B cover and prepare to access internal components:

**WARNING**

**TO AVOID EXPLOSION OR FIRE, BE CAREFUL NOT TO SHORT THE BATTERY TERMINALS.**

1. Remove the ac line cord from the rear panel.
2. Remove the six screws that fasten the top cover to the chassis. Three screws are located on each side of the instrument cover near the bottom.
3. Lift off the top cover.

### Replacing the Battery 5-12.

For preventive maintenance, replace the battery every 18 to 24 months if the 72 hour battery backup time is important. If the battery fails to switch from high-current charging mode to trickle voltage mode, either the charger is defective or the battery needs replacement. Troubleshooting procedures for the A5 Battery Charger are presented further on in this section.

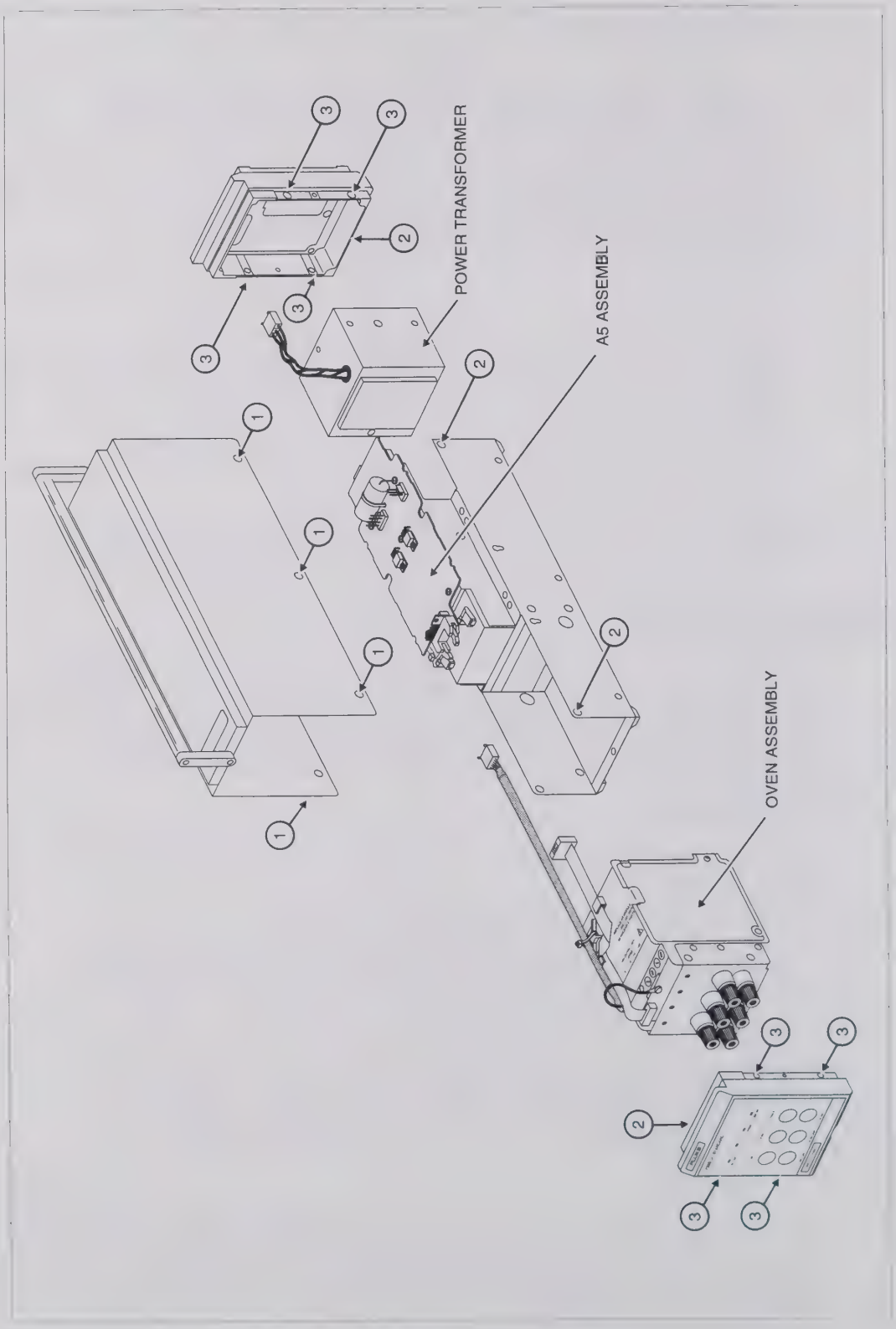


**Figure 5-3. Accessing Internal Components**

The correct battery is available from Fluke by ordering Fluke P/N 887042. Refer to Figure 5-4 and proceed as follows to replace the battery:

**WARNING**

**WEAR EYE PROTECTION. USE EXTREME CARE NOT TO SHORT THE BATTERY TERMINALS. THE BATTERY MAY EXPLODE IF SHORTED.**

1. Leave the ac power on to maintain calibration. Remove any cables connected to the MONITOR/EXT BAT IN connector.
2. Set the rear panel BAT switch to O.
3. Remove the six screws that fasten the top cover and remove the cover.
4. Disconnect the 4-pin, 2-wire connector from the battery where it connects to the A5 assembly.
5. Free the ribbon cable that comes from the front panel from its hold-down guides, leaving it connected to the A5 assembly.
6. Pull off the red battery terminal lead.
7. Remove the four screws that fasten the battery hold-down bracket (which supports the A5) to the chassis.
8. Wiggle the battery hold-down bracket until it breaks loose from the foam backing.
9. Lift the front edge of the battery hold-down bracket as shown in view A of Figure 5-4.
10. Pull the battery hold-down bracket forward until it clears the rear bezel, then rotate it 90° and position it in the keyholes as shown in view B of Figure 5-4.
11. Disconnect the black battery terminal lead and lift out the battery.
12. Put a new battery in place.
13. Connect the black battery terminal lead only.
14. Slide the battery hold-down bracket in at the rear first as it came out, drop it into place, and check for pinched wires.
15. Install the four battery hold-down bracket screws loosely first, then tighten them.
16. Reconnect the red battery terminal lead.
17. Reconnect the 4-pin connector from the battery to the A5 assembly. (Verify correct polarity.)
18. Hook the ribbon cable that comes from the front panel under its two guides.
19. Check all connections for tightness.
20. Reinstall the top cover.
21. Set the BAT switch to | and disconnect ac line power. Verify that the IN CAL indicator remains lit.
22. Reconnect ac line power for normal operation.

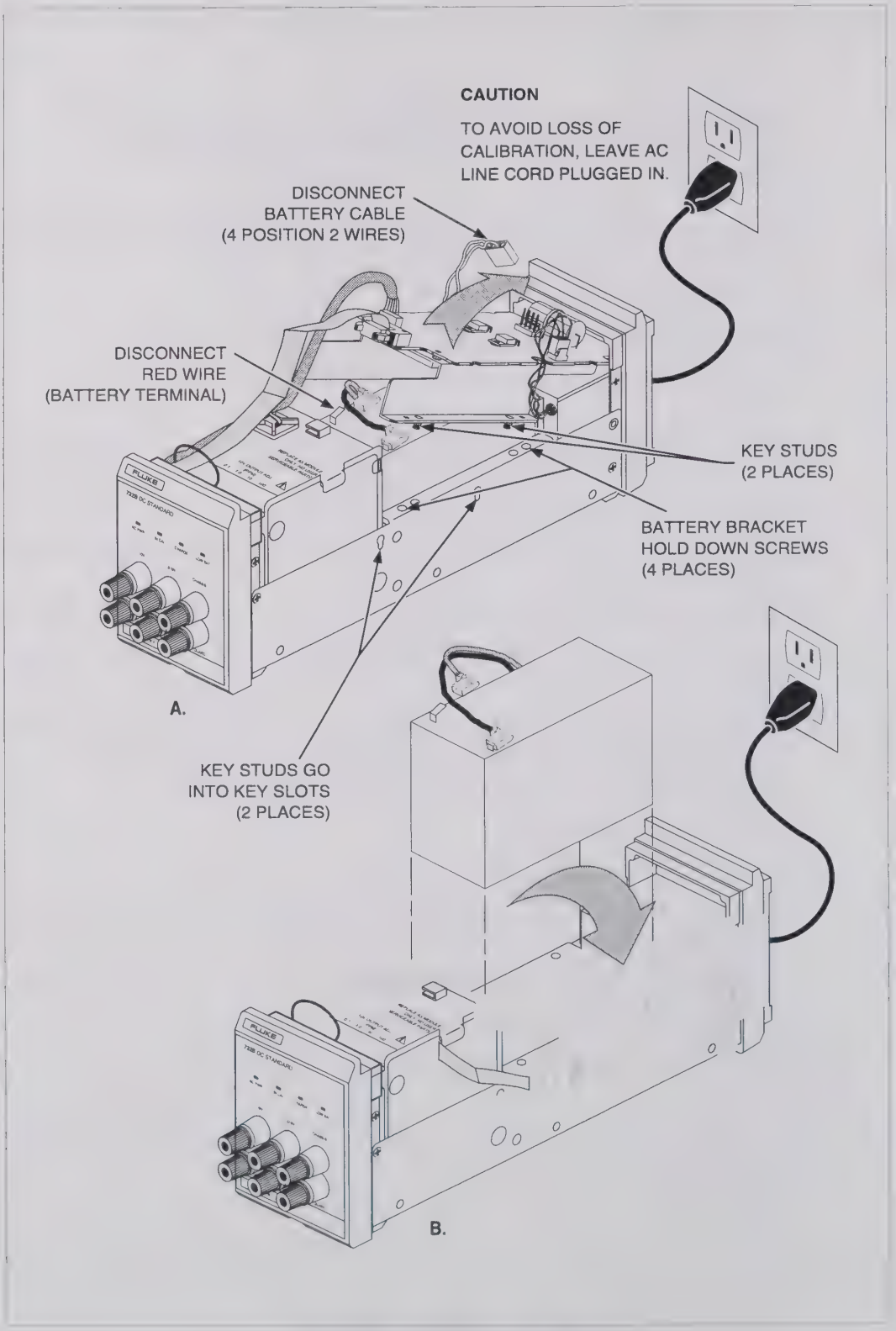
CAUTION
TO AVOID LOSS OF CALIBRATION, LEAVE AC LINE CORD PLUGGED IN.
DISCONNECT BATTERY CABLE (4 POSITION 2 WIRES)
DISCONNECT RED WIRE (BATTERY TERMINAL)
KEY STUDS (2 PLACES)
BATTERY BRACKET HOLD DOWN SCREWS (4 PLACES)
A.
KEY STUDS GO INTO KEY SLOTS (2 PLACES)
B.

**Figure 5-4. Replacing the Battery**

## Replacing the Oven Assembly 5-13.

Refer to "Troubleshooting" to confirm the necessity of replacing the oven (reference) assembly. Assembled and tested reference assemblies are available from Fluke as P/N 869193. To replace the oven assembly, which contains the 10V reference circuitry, proceed as follows:

1. Do the steps under "Initial Access Procedure."
2. Disconnect the two cables that are attached to the A5 assembly at the oven assembly.
3. Refer to Figure 5-3 and remove the three screws that fasten the front panel and oven to the chassis (one on each side and one on the bottom).
4. Remove the four screws (two on each side) that fasten the oven to the front panel bezel.
5. Remove the oven assembly. Refer to the parts list illustration for the 732B Final Assembly for further breakdown information.
6. Reverse the steps to install a new oven assembly.

## Accessing the A5 Battery Charger 5-14.

Proceed as follows to access A5 Battery Charger/Power Supply assembly for troubleshooting or replacement.

1. Do the steps under "Initial Access Procedure."
2. The component side of the A5 assembly is now accessible for probing if you are troubleshooting the board.
3. To remove the A5 assembly, disconnect all four cables from the board.
4. Remove the two screws that fasten the U504 and U500 TO-220 packages to the battery hold-down bracket.
5. Remove the five screws that fasten the A5 assembly to the battery hold-down bracket.
6. Remove the A5 assembly. Be careful not to lose the four insulators from step 4.
7. When you reinstall the A5 assembly, reinstall the screws through the tabs on U504 and U500 before you reinstall the rest of the screws. Be careful to include the isolation washers under the tabs.

## Removing the Power Transformer Assembly 5-15.

Proceed as follows to remove the power transformer assembly:

1. Do the steps under "Initial Access Procedure."
2. Remove any cable attached to the rear panel.
3. Disconnect the 3-position cable from the power transformer assembly where it plugs onto the A5 assembly.
4. Remove the three screws that fasten the rear panel and transformer assembly to the chassis (one on each side and one on the bottom).
5. Slide the rear panel and transformer assembly (still fastened together) slightly back and out of the way.
6. Remove the four screws (two on each side) that fasten the rear panel to the power transformer assembly.
7. Remove the power transformer assembly.

## TROUBLESHOOTING 5-16.

When a problem occurs with the 732B, first verify that the battery is good and that the line power fuse is intact. Then you need to determine if the problem is in the 10V reference circuitry or the A5 Battery Charger/Power Supply assembly.

Presented first is a simple performance test for troubleshooting the 10V reference circuitry. If the 10V reference circuit is faulty, the complete oven assembly must be replaced as a unit. The reason for this is that repairing the reference circuitry can disrupt the stability of the standard.

Following the 10V reference performance test is a detailed troubleshooting procedure for the A5 Battery Charger/Power Supply. If you believe that the reference circuitry is faulty, review the A5 troubleshooting information first. Make sure that the problem is not in the A5 assembly before you replace an oven assembly.

### 10V Reference Performance Test 5-17.

To check for a failure in the 10V reference circuitry, look for any of the following symptoms (assuming that you have allowed a warmup period of at least 24 hours):

1. The 10V output is further than ±3 mV from 10V.
2. The 1.018V output is further than ±1.5 mV from 10V.
3. When the 10V output is shorted, the short circuit current is greater than 50 mA.
4. The 10V output is excessively noisy with consistent dvm rattle of greater than 5 μV (using a 6-1/2 or 7-1/2 digit dvm with sampling no faster than 1 per second and with filtering on).
5. The 1.018V output is excessively noisy with consistent dvm rattle of greater than 2 μV (using a 6-1/2 or 7-1/2 digit dvm with sampling no faster than 1 per second and with filtering on).

### Troubleshooting the A5 Battery Charger Assembly 5-18.

There are six functional circuit groups in the A5 assembly:

1. Transformer/Rectifier/Filter
2. Battery Charger
3. +11.5V Preregulator
4. +11.5V Regulator
5. -6V Supply
6. IN CAL LED Logic

These groups are linked together but are autonomous enough to be checked independently on an input/output basis. The following information describes the circuits where necessary for understanding the troubleshooting method, but not in detail. For a more detailed circuit description, refer to Section 4. To locate test points and components, refer to the schematic and parts placement diagrams in Section 7.

### TRANSFORMER/RECTIFIER/FILTER 5-19.

The transformer/rectifier/filter functional group is composed of the transformer assembly, the overvoltage detect circuit, the rectifier bridge, and the capacitive filter. The transformer provides a secondary voltage of 25V rms, or about 30V pk.

The best way to troubleshoot this section is to use an oscilloscope at TP501 and at the secondary input connector J501. The ripple voltage at TP501 should be approximately 400 mV p-p. You can check the overvoltage detect circuit by using a variable ac source with some current limiting. The overvoltage detect circuit should short out the secondary when it trips.

Use the following guide to symptoms and possible faults:

Symptom 1: No voltage at TP501

Check: Cable, secondary voltage, diodes CR501-504, C502, C503, or C504.

Symptom 2: Charger puts out approximately 12V dc but will not go higher.

Check: To see that the ac line voltage selector is in the 120V ac position. These symptoms will occur if the selector is in the 220V ac position and 120V ac is applied.

## BATTERY CHARGER 5-20.

The battery charger is a dual mode charger. In one mode it acts as a current source of 234 mA. In the other mode, it acts as a voltage source with a finite source impedance. IC U501, pins 6, 7, and 1 act as the sensing comparator for switching between these modes.

If the battery charger doesn't work correctly, start by removing ac power and the battery connections and replacing the battery with a 51Ω, 3W resistor or resistor network. Power the unit with ac and check to see that the voltage across the resistor is consistent with a current of 234 mA (11.93V dc nominal). This checks the whole current source section of the circuit.

If the voltage across R502 or R503 is not 1.25V dc in the current mode, first check to see that SW502 is closed, then check U500 or the protection diode CR505. The sensing circuit is supposed to switch from the current mode to the voltage mode when the voltage across the battery is 15.3V dc. This is equivalent to a battery impedance of 65.38Ω. You can simulate this impedance using a variable resistor from 50 to 70Ω, but make sure the resistor is able to dissipate the required power. If the circuit doesn't switch from the current mode to the voltage mode, check the U501 comparator and Q502 switch.

## +11.5V DC PREREGULATOR 5-21.

The +11.5V DC Preregulator circuit is a constant-voltage supply set by U504 and resistors R531 and R532. The output is nominally +14.9V dc. If the voltage is too high, check resistors R531 and R532, and U504 and CR507.

The battery switch relay circuit should switch the state of relay K500 when the voltage at the output of U504 falls below about 14V dc. At this point, the zener stops conducting, and transistor Q503 switches off, thus de-energizing relay K500. Check the trip point of the relay switching circuit by reducing the voltage. Use either method 1 or 2:

1. Insert a potentiometer in parallel with R532 to reduce the effective resistance of R532 to reduce the voltage in a controlled manner.

2. Parallel R532 with a 4.12 kΩ resistor. This will drop the voltage to 12V dc.

## +11.5V DC REGULATOR 5-22.

The input and output of the +11.5V dc regulator circuit can be easily checked at TP507 and TP508. The input should be nominally 14.87V dc. The normal range is 14.52 to 15.20V dc. If there is no voltage at the 10V output binding posts, check F501 first. If okay, check the regulator circuit around Q504. The reference voltage used for this circuit comes from U505, pin 6 and is +10.00V dc. Check U506 pin 3 to see that the feedback divider is at the proper ratio, which is $V3/V_{out} = 0.870$.

## -6V DC SUPPLY 5-23.

The -6V dc supply consists almost entirely of U511. Check the -6V output at U511 pin 5 or at J504 pin 6 to verify the output. If it is bad, first disconnect J504 and recheck the output. If it is now good, this confirms that something downstream from the cable is at fault. If still bad, check to see that $V_{cc}$ and Common are correct on U511. If they are correct, replace U511. Also check C524, C525 and C527 to confirm that they are not damaged.

## IN CAL LED LOGIC 5-24.

The IN CAL LED logic is controlled as follows: IN CAL LED(*) = TempHi(*) OR TempLo(*) OR BattLo(*), where (*) = asserted low.

When the oven temperature is at nominal, TEMP-SENSE is approximately +8.14V dc. If the oven temperature rises above 55C, this signal voltage increases to above +9.02V and a comparator in U507 changes state. Similarly, if the oven temperature falls to below 35C, the TEMP-SENSE voltage decreases to below +6.98V dc and a comparator in U507 changes state. If the VBATT line (battery voltage) falls to below +11.16V dc, a comparator in U507 changes state.

Any of these actions (temperature too high or low or operating voltage too low) cause the IN CAL LED to go out. You can check each trip condition individually by using a variable source on the TEMP-SENSE line as follows:

1. Check to see that +10V-REF is very close to 10V. This comes from U505 and should be quite stable.
2. Check VBATT to see that it is greater than +12V dc.
3. Disconnect J504 and connect a variable dc source to either J504 pin 5 or to TP513. Vary the source and look at the wired-OR connection at TP512. Make sure you are checking only one logic variable at a time. If there is a problem with any of these comparators, replace U507.

The IN CAL LED is latched through the NAND gates in U509. If there is a problem with this, check SW501 or U509. The external IN CAL indicator, available at J502 on the rear panel, can be checked by varying the IN-CAL-LED(*) signal line and observing that Q506 changes state, that current through the optoisolator changes state, and that the output transistor in the optoisolator changes state. Be sure to use a 10 k pullup resistor between U513 pin 7 (or J502 pin 7) and U513 pin 8 (or J502 pin 3).

# Chapter 6
# List of Replaceable Parts

TABLE OF CONTENTS


| ASSEMBLY NAME | DRAWING NO. | TABLE NO. | TABLE PAGE | FIGURE NO. | FIGURE PAGE |
|---|---|---|---|---|---|
| 734A DC Reference Standard | 734A-5001 | 6-1 | 6-4 | 6-1 | 6-5 |
| 732B DC Standard | 732B-5001 | 6-2 | 6-5 | 6-2 | 6-10 |
| A1 Front Panel PCA | 732B-7601 | 6-3 | 6-15 | 6-3 | 6-16 |
| A5 Power Supply PCA | 732B-7605 | 6-4 | 6-17 | 6-4 | 6-19 |

## INTRODUCTION 6-1.

This section contains an illustrated list of replaceable parts for the 734A, and 732B. Parts are listed by assembly; alphabetized by reference designator. Each assembly is accompanied by an illustration showing the location of each part and its reference designator. The parts lists give the following information:

- Reference designator
- An indication if the part is subject to damage by static discharge
- Description
- Fluke stock number
- Manufacturers supply code
- Manufacturers part number or generic type
- Total quantity
- Any special notes (i.e., factory-selected part)

**CAUTION**

**A ϟ symbol indicates a device that may be damaged by static discharge.**

## HOW TO OBTAIN PARTS 6-2.

Electrical components may be ordered directly from the manufacturer by using the manufacturers part number, or from the Fluke Corporation and its authorized representatives by using the part number under the heading FLUKE STOCK NO. In the U.S., order directly from the Fluke Parts Dept. by calling 1-800-526-4731. Parts price information is available from the Fluke Corporation or its representataives. Prices are also available in a Fluke Replacement Parts Catalog which is available on request.

In the event that the part ordered has been replaced by a new or improved part, the replacment will be accompanied by an explanatory note and installation instructions, if necessary.

To ensure prompt delivery of the correct part, include the following information when you place an order:

- Fluke stock number
- Description (as given under the DESCRIPTION heading)
- Quantity
- Reference designator
- Part number and revision level of the pca containing the part.
- Instrument model and serial number

## MANUAL STATUS INFORMATION 6-3.

The Manual Status Information table that precedes the parts list defines the assembly revision levels that are documented in the manual. Revision levels are printed on the component side of each pca.

## NEWER INSTURMENTS 6-4.

Changes and improvements made to the instrument are indentified by incrementing the revision letter marked on the affected pca. These changes are documented on a supplemental change/errata sheet which, when applicable, is included with the manual.

## SERVICE CENTERS 6-5.

A list of service centers is located at the end of this section.

*NOTE* Ni-Cd

*This instrument may contain a Nickel-Cadmium battery. Do not mix with the solid waste stream. Spent batteries should be disposed of by a qualified recycler or hazardous materials handler. Contact your authorized Fluke service center for recycling information.*

### MANUAL STATUS INFORMATION

| REF OR OPTION NO. | ASSEMBLY NAME | FLUKE PART NO. | REVISION LEVEL |
|---|---|---|---|
| A1 | Front Panel PCA | 869169 | B |
| A5 | Power Supply PCA | 869185 | E |

**Table 6-1. 734A DC Reference Standard**

| REFERENCE DESIGNATOR | DESCRIPTION | FLUKE STOCK NO | MFRS SPLY CODE | MANUFACTURERS PART NUMBER OR GENERIC TYPE | TOT QTY | NOTES |
|---|---|---|---|---|---|---|
| A 732 | 732B DC STANDARD | 869297 | 89536 | 869297 | 4 | |
| H 500 | SCREW,PH,P,LOCK,STL,6-32,.250 | 152140 | 74594 | 152140 | 14 | |
| H 515 | SCREW,FHU,P,LOCK,SS,6-32,.250 | 769893 | 73734 | 6-32X1/4FHUCPS2A | 22 | |
| H 540 | SCREW,CAP,SCKT,SS,8-32,.375 | 295105 | 89536 | 295105 | 20 | |
| H 565 | SCREW,KNURL,SL,CAPT,SS,10-32,1.750 | 912436 | 89536 | 912436 | 4 | |
| H 570 | RIVET,BUTTON,NYL,.125,.330 | 927533 | 0HFJ2 | 27PIF0039 | 12 | |
| MP 509 | BARREL NUT | 868984 | 89536 | 868984 | 4 | |
| MP 513 | INST TOP COVER | 869011 | 89536 | 869011 | 1 | |
| MP 514 | INST BOTTOM COVER | 869016 | 89536 | 869016 | 1 | |
| MP 515 | REAR PANEL | 868989 | 89536 | 868989 | 1 | |
| MP 516 | GUIDE PIN | 869029 | 89536 | 869029 | 4 | |
| MP 520 | BOTTOM FOOT, MOLDED | 868786 | 89536 | 868786 | 4 | |
| MP 524 | HANDLE,INSTRUMENT | 886333 | 89536 | 886333 | 4 | |
| MP 528 | SIDE TRIM INSERT | 878934 | 89536 | 878934 | 2 | |
| MP 530 | CHASSIS ASSEMBLY | 878939 | 89536 | 878939 | 1 | |
| MP 531 | SIDETRIM | 869052 | 89536 | 869052 | 2 | |
| MP 533 | DECAL, FRONT PANEL | 869326 | 89536 | 869326 | 1 | |
| MP 534 | BEZEL BOTTOM,PAINTED | 921908 | 89536 | 921908 | 1 | |
| MP 535 | PAWL,PAINTED | 921903 | 89536 | 921903 | 4 | |
| MP 539 | BEZEL TOP,PAINTED | 921911 | 89536 | 921911 | 1 | |
| MP 540 | SPRING,COIL,EXT,LOOP END,SS,.500,.125 | 912423 | 89536 | 912423 | 4 | |
| MP 544 | SPRING,COIL,COMP,SS,1.00,.240 | 912428 | 89536 | 912428 | 4 | |
| TM 1 | 732B/734A INSTRUCTION MANUAL | 869321 | 89536 | 869321 | 1 | 1 |
| W 503 | RECEPTACLE CABLE | 921890 | 89536 | 921890 | 1 | |
| W 504 | CORD,LINE,5-15/IEC,3-18AWG,SVT,7.5 FT | 284174 | 70903 | 17239 | 1 | |
| NOTES: | ϟ Static sensitive part.<br>1. ONE MANUAL PROVIDED WHEN ORDERING A 734A. | | | | | |

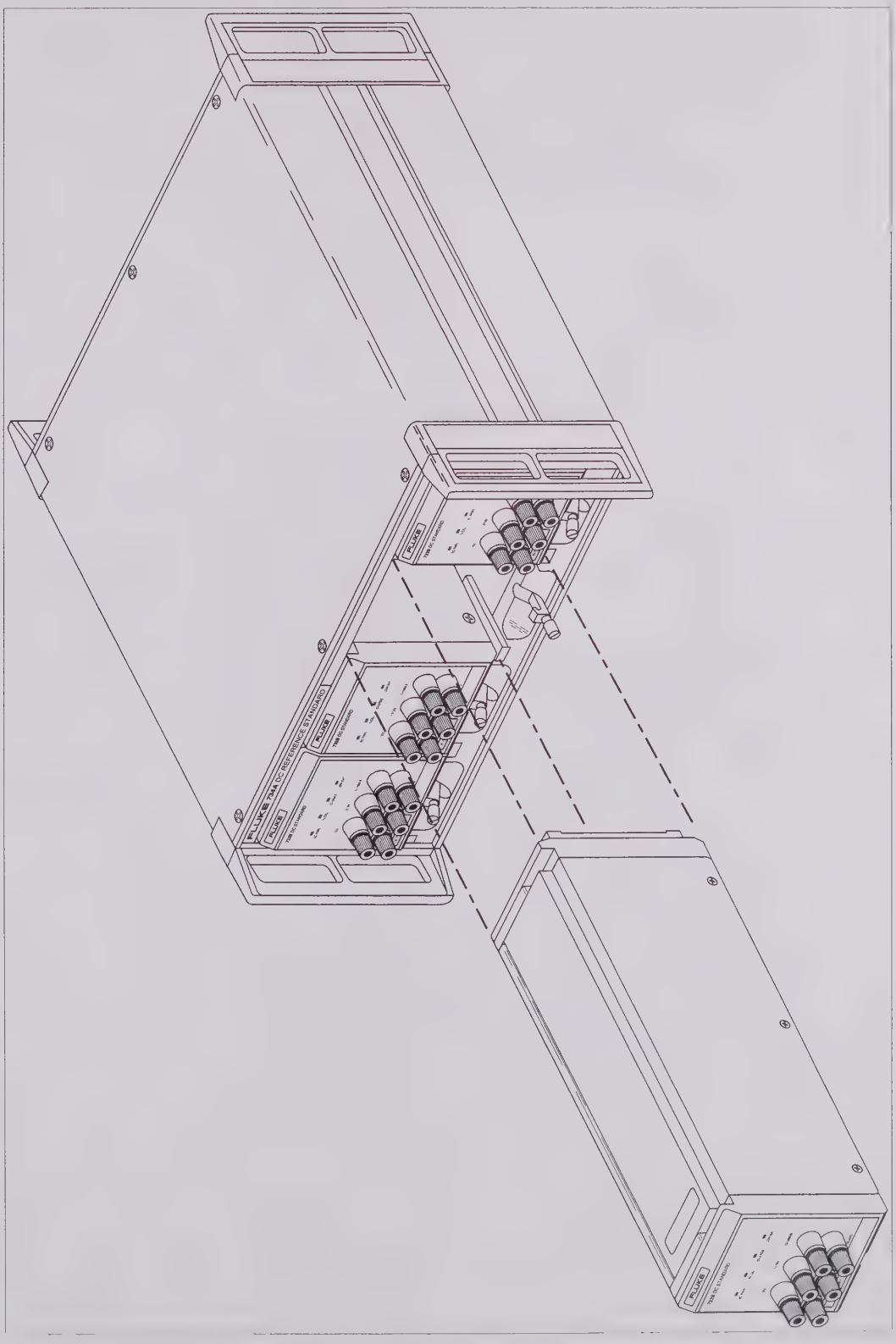


**Figure 6-1. 734A DC Reference Standard**

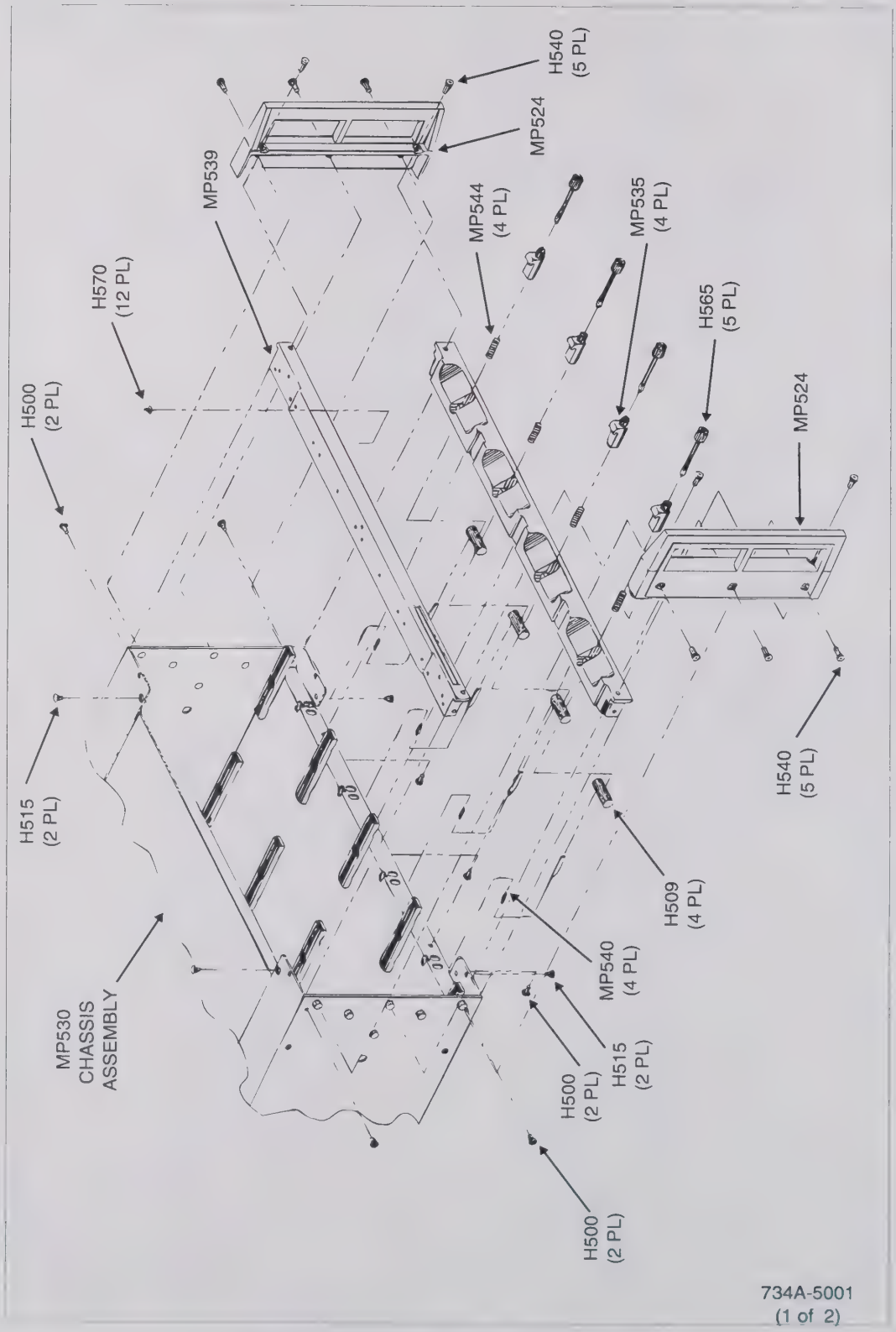


**Figure 6-1. 734A DC Reference Standard (cont)**

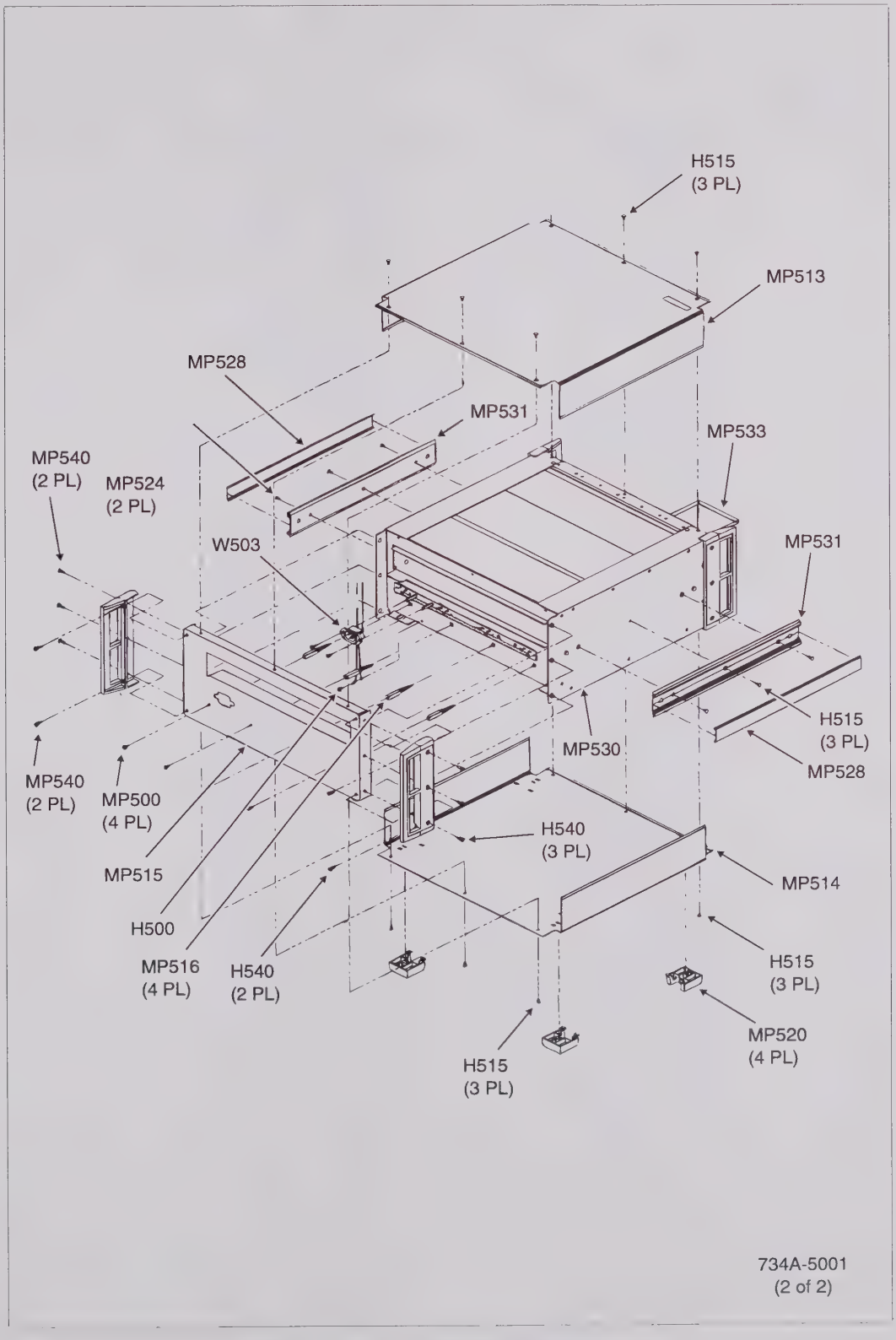


**Figure 6-1. 734A DC Reference Standard (cont)**

## Table 6-2. 732B DC Standard

| REFERENCE DESIGNATOR | DESCRIPTION | FLUKE STOCK NO | MFRS SPLY CODE | MANUFACTURERS PART NUMBER OR GENERIC TYPE | TOT QTY | NOTES |
|---|---|---|---|---|---|---|
| A 1 | ϟ FRONT PANEL PCA | 869169 | 89536 | 869169 | 1 | |
| A 5 | ϟ POWER SUPPLY PCA | 869185 | 89536 | 869185 | 1 | |
| BT 401 | BATTERY,LEAD-ACID,12V,6.5AH | 887042 | 50120 | CFM12V6.5 | 1 | |
| F 1 | FUSE,.25X1.25,0.25A,250V,FAST | 109314 | 71400 | AGC1-4 | 1 | |
| H 112 | WASHER,LOCK,INTRNL,STL,.512ID | 641381 | 89536 | 641381 | 1 | |
| H 146 | WASHER,FLAT,BRASS,#8,0.032 THK | 631606 | 86928 | 5724-162-32 | 5 | |
| H 174 | SCREW,FHU,P,LOCK,SS,6-32,.250 | 769893 | 73734 | 6-32X1/4FHUCPS2A | 16 | |
| H 225 | SCREW,FH,P,LOCK,STL,4-40,.250 | 114884 | 74594 | 114884 | 1 | |
| H 226 | SCREW,PH,P,LOCK,STL,4-40,.250 | 129890 | 74594 | 129890 | 2 | |
| H 303 | SCREW,PH,P,LOCK,STL,6-32,.312 | 152157 | 74594 | 152157 | 4 | |
| H 312 | SCREW,PH,P,LOCK,STL,6-32,.250 | 152140 | 74594 | 152140 | 16 | |
| H 504 | SCREW,CAP,SCKT,SS,8-32,.375 | 295105 | 74594 | 295105 | 2 | |
| H 618 | SCREW,FHU,P,SS,6-32,.312 | 867234 | | COMMERCIAL | 6 | |
| H 625 | WASHER,SHLDR,NYLON,.118,.250 | 807560 | 89536 | A364-164 | 2 | |
| MP 100 | ϟ REFERENCE MODULE ASSEMBLY | 869193 | 89536 | 869193 | 1 | |
| MP 103 | GUARD TOP | 878918 | 89536 | 878918 | 1 | |
| MP 104 | GUARD BOTTOM | 878921 | 89536 | 878921 | 1 | |
| MP 106 | BEZEL | 871819 | 89536 | 871819 | 2 | |
| MP 107 | FRONT PANEL DECAL | 871827 | 89536 | 871827 | 1 | |
| MP 108 | FRONT PANEL | 871876 | 89536 | 871876 | 1 | |
| MP 111 | GROUND ADAPTER, BINDING POST | 882998 | 89536 | 882998 | 1 | |
| MP 113 | INSULATOR,BINDING POST,FRONT,BLACK | 860411 | 89536 | 860411 | 6 | |
| MP 119 | INSULATOR,REAR,BINDING POST,BLACK | 860361 | 89536 | 860361 | 5 | |
| MP 125 | BINDING POST-RED | 860452 | 89536 | 860452 | 2 | |
| MP 127 | BINDING POST, BLACK | 860457 | 89536 | 860457 | 2 | |
| MP 129 | BINDING POST, GREEN | 871616 | 89536 | 871616 | 1 | |
| MP 130 | BINDING POST, BLUE | 871637 | 89536 | 871637 | 1 | |
| MP 140 | CABLE ACCESS,TIE,4.00L,.10W,.75 DIA | 172080 | 06383 | SST-1M | 3 | |
| MP 143 | GROUND STRIP,BECU,SPRING FINGER | 370619 | 34641 | 97-500-01 | 1 | |
| MP 144 | CABLE ACCESSORY,CLAMP,ADHESIVE,NYLON | 838300 | 06915 | MWSSEB-1-01A | 2 | |
| MP 151 | CABLE TIE,MOUNT,ADHESIVE,0.19" WIDTH | 565036 | 06383 | ABM2S-AT-0 | 1 | |
| MP 155 | WASHER, LOW THERMAL #8 | 859939 | | COMMERCIAL | 9 | |
| MP 164 | NUT, #8 LOW THERMAL | 850334 | | COMMERCIAL | 11 | |
| MP 196 | CORE,BEAD,FERRITE,.562X.25X.53 | 876979 | 89536 | 876979 | 4 | |
| MP 228 | O-RING,SYN RUBBER,.208 ID,.070 WIDE | 910815 | 2K160 | 2-009 | 2 | |
| MP 307 | REAR PANEL | 878884 | 89536 | 878884 | 1 | |
| MP 314 | FLUKE NAMEPLATE | 879770 | S5900 | 879770 | 1 | |
| MP 315 | LABEL,ADHES,VINYL,BAR CODE,1.500,.312 | 844712 | 22670 | 844712 | 1 | |
| MP 401 | TERMINAL MTG ASSY | 878947 | 89536 | 878947 | 1 | |
| MP 402 | BATTERY BRACKET | 878897 | 89536 | 878897 | 1 | |
| MP 405 | CHASSIS ASSEMBLY | 878942 | 89536 | 878942 | 1 | |
| MP 502 | HANDLE ARM/REAR FOOT | 871868 | 89536 | 871868 | 2 | |
| MP 506 | TOP COVER, PAINTED | 871962 | 89536 | 871962 | 1 | |
| MP 508 | HANDLE, PAINTED | 871959 | 89536 | 871959 | 1 | |
| MP 602 | INSUL PART,DIODE,POLYIMIDE,.130,.375 | 887307 | 14601 | KA-038-013 | 2 | |
| MP 606 | FRONT PANEL MOUNTING BRACKET | 921916 | 89536 | 921916 | 1 | |
| MP 636 | FOOT,RUBBER,ADHES,BLK,.50 SQ,.23 THK | 887047 | 28213 | SJ5018-BLK | 4 | |
| MP 703 | OVEN FOAM | 871806 | 89536 | 871806 | 1 | |
| MP 704 | FOAM PLUG, INNER | 871801 | 89536 | 871801 | 1 | |
| MP 705 | FOAM PLUG, OUTER | 871814 | 89536 | 871814 | 1 | |
| MP 706 | OVEN TOP COVER | 869110 | 89536 | 869110 | 1 | |
| MP 707 | TERMINAL EXTENSION | 869102 | 89536 | 869102 | 4 | |
| T 633 | TRANSFORMER ASSY | 878967 | 89536 | 878967 | 1 | |

Table 6-2. 732B DC Standard (cont)

| REFERENCE DESIGNATOR | DESCRIPTION | FLUKE STOCK NO | MFRS SPLY CODE | MANUFACTURERS PART NUMBER OR GENERIC TYPE | TOT QTY | NOTES |
|---|---|---|---|---|---|---|
| TM 1 | 732B/734A INSTRUCTION MANUAL | 869321 | 89536 | 869321 | 1 | |
| W 230 | CORD,LINE,5-15/IEC,3-18AWG,SVT,7.5 FT | 284174 | 70903 | 17239 | 1 | |
| W 640 | CABLE, BATTERY | 869198 | 89536 | 869198 | 1 | |
| NOTES: | ϟ Static sensitive part. | | | | | |

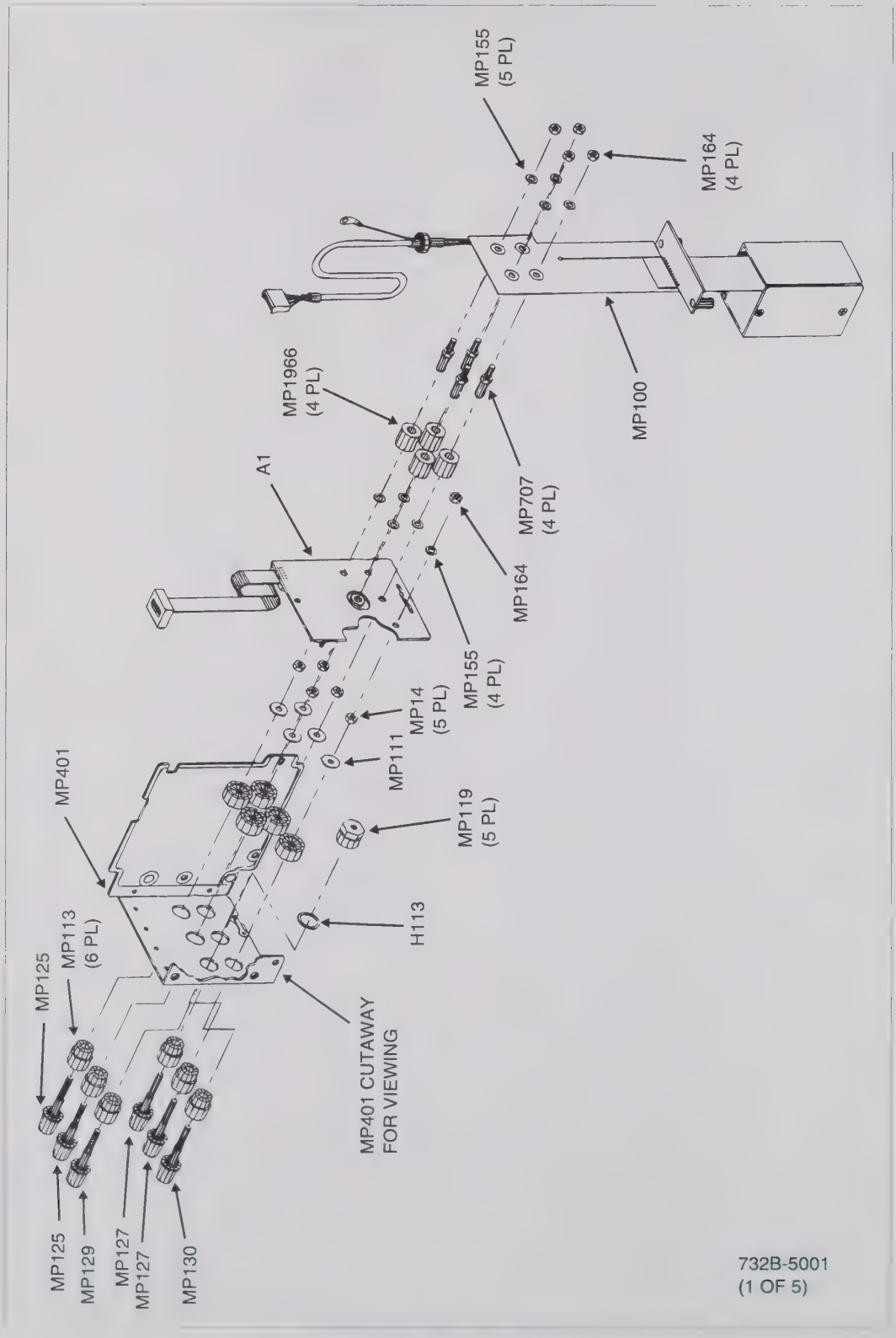


**Figure 6-2. 732B DC Standard**

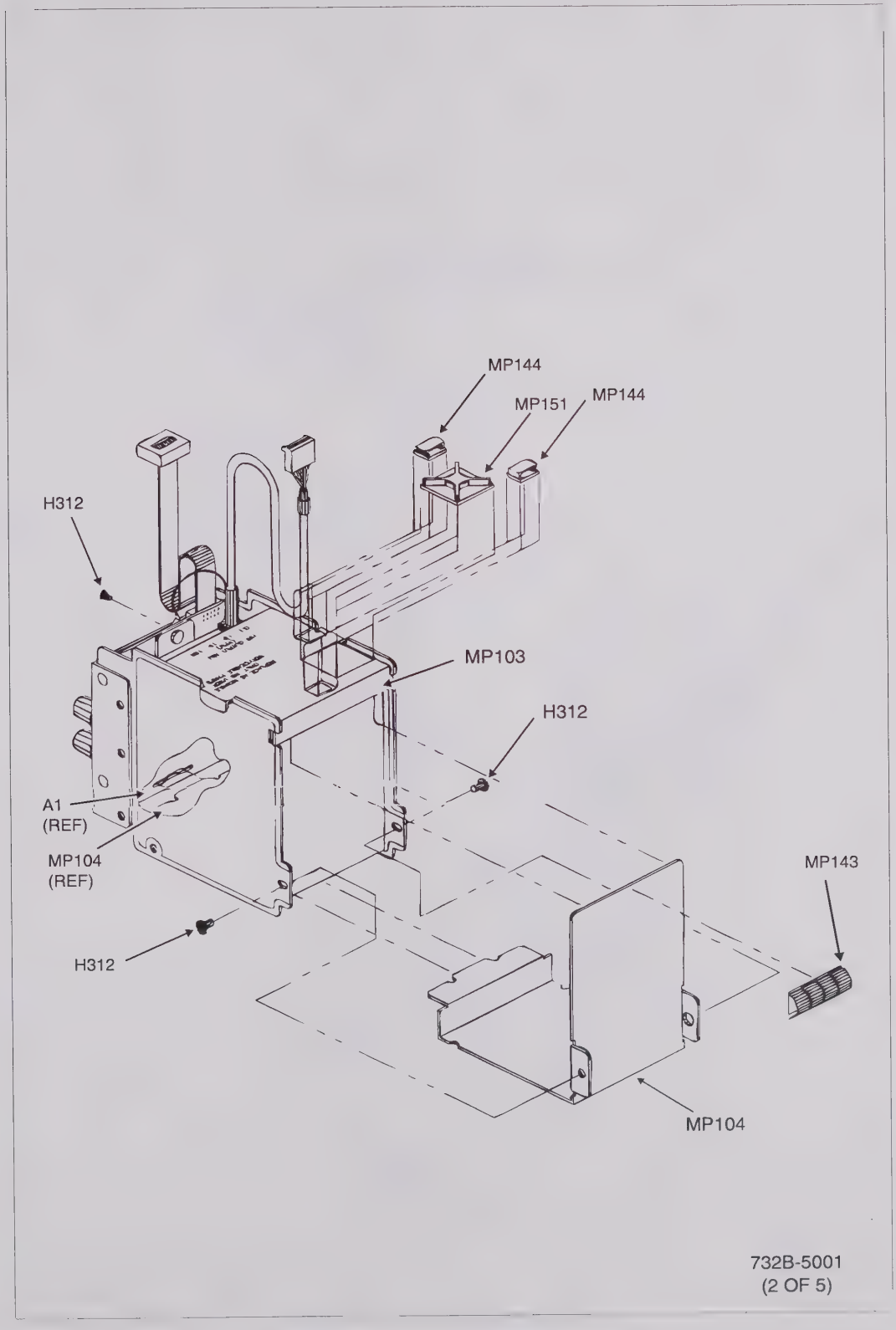


**Figure 6-2. 732B DC Standard (cont)**

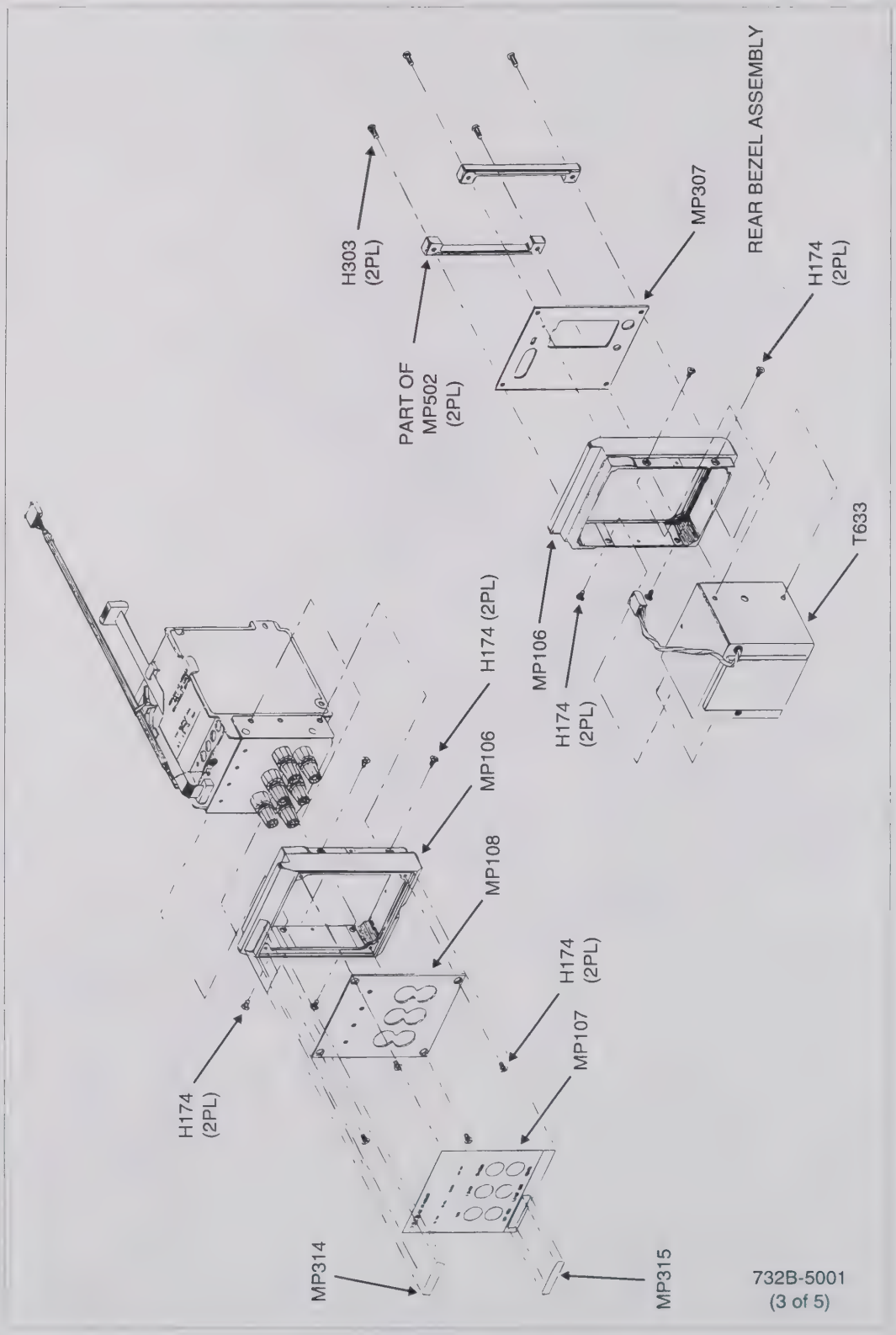


**Figure 6-2. 732B DC Standard (cont)**

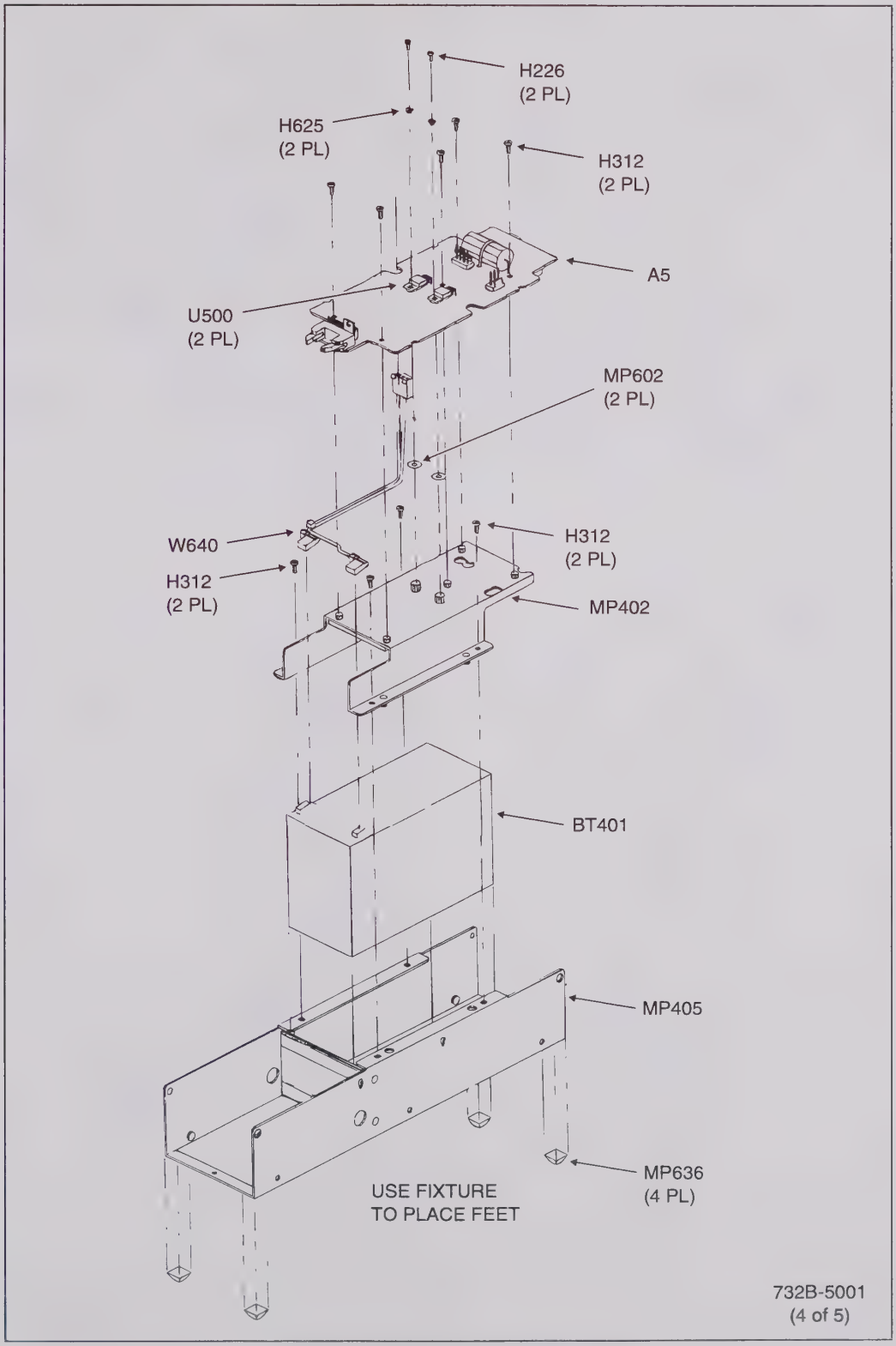


**Figure 6-2. 732B DC Standard (cont)**

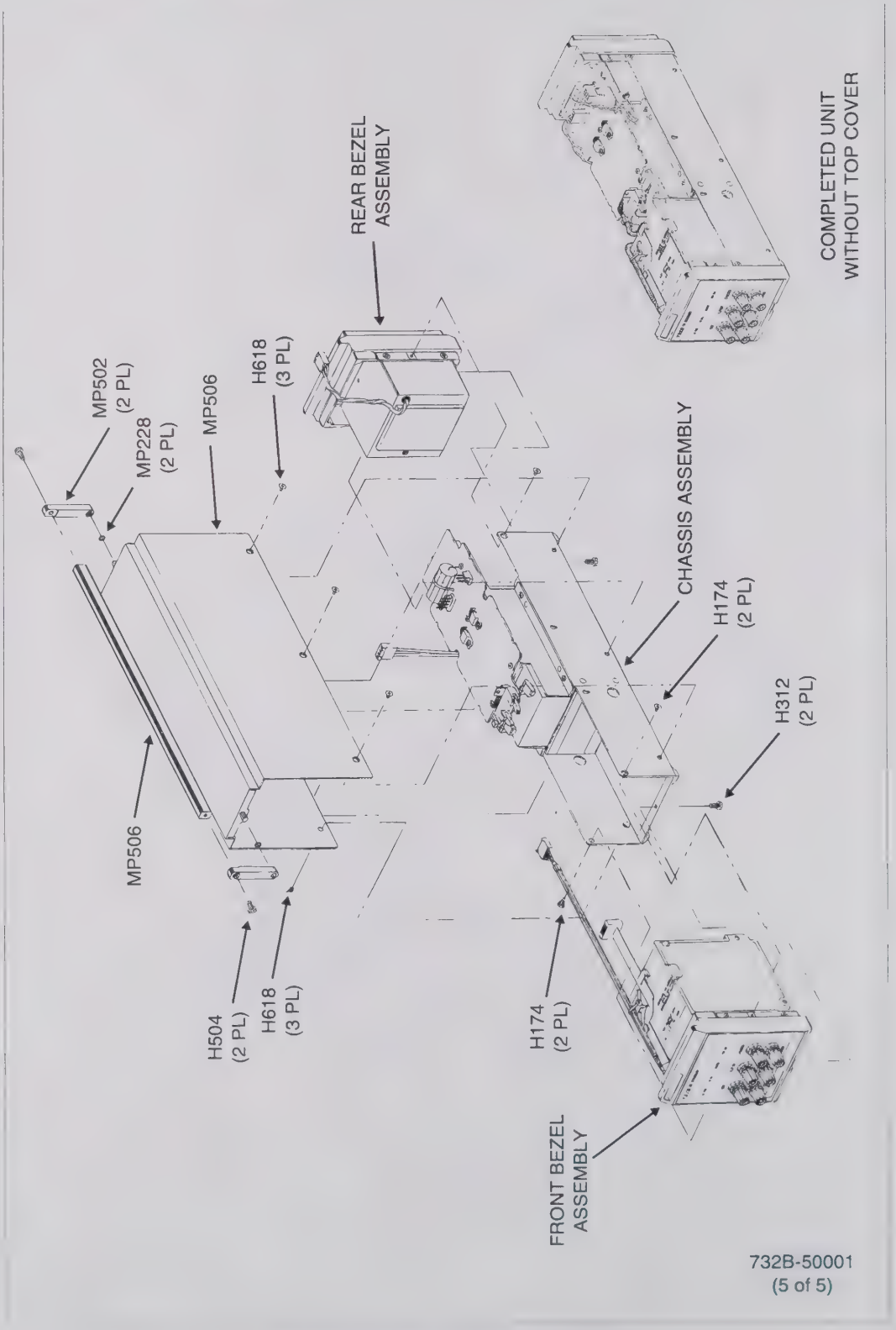


**Figure 6-2. 732B DC Standard (cont)**

## Table 6-3. A1 Front Panel PCA

| REFERENCE DESIGNATOR | | DESCRIPTION | FLUKE STOCK NO | MFRS SPLY CODE | MANUFACTURERS PART NUMBER OR GENERIC TYPE | TOT QTY | NOTES |
|---|---|---|---|---|---|---|---|
| C 100 | | CAP,POLYES,0.1UF,+-10%,50V | 649913 | 68919 | MKS2104K50B | 1 | |
| C 101 | | CAP,TA,1UF,+-20%,35V | 697417 | 56289 | 199D105X0035AG2 | 1 | |
| CR 100-103 | | LED,RED,T1,2 MCD | 875666 | 28480 | HLMP-K155 | 4 | |
| CR 104 | | DIODE,SI,100 PIV,5.0 AMP | 483701 | 12969 | UES1301 | 1 | |
| E 100 | | SURGE PROTECTOR,230V,+-15% | 500363 | 50579 | B1-A230 | 1 | |
| MP 100-103 | | SPACER,LED MOUNT,PVC,.375 | 887067 | 89536 | 887067 | 4 | |
| Q 100 | ϟ | TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92 | 698225 | 27014 | 2N3904 | 1 | |
| R 100-103,106 | | RES,MF,10K,+-1%,0.125W,100PPM | 719476 | 91637 | CMF-55 1002F T-1 | 5 | |
| R 104 | | RES,MF,1M,+-1%,0.125W,100PPM | 719492 | 91637 | CMF-55 1004F T-1 | 1 | |
| R 105 | | RES,MF,590,+-1%,0.125W,100PPM | 866236 | 91637 | CMF-55 5900F T-1 | 1 | |
| U 100 | ϟ | IC,CMOS,TIMER | 742254 | 01295 | TLC555CP | 1 | |
| VR 101 | ϟ | ZENER,TRANS SUPPRESSOR,11V,5% | 912381 | 04713 | 1.5KE11A | 1 | |
| NOTES: | ϟ | Static sensitive part. | | | | | |

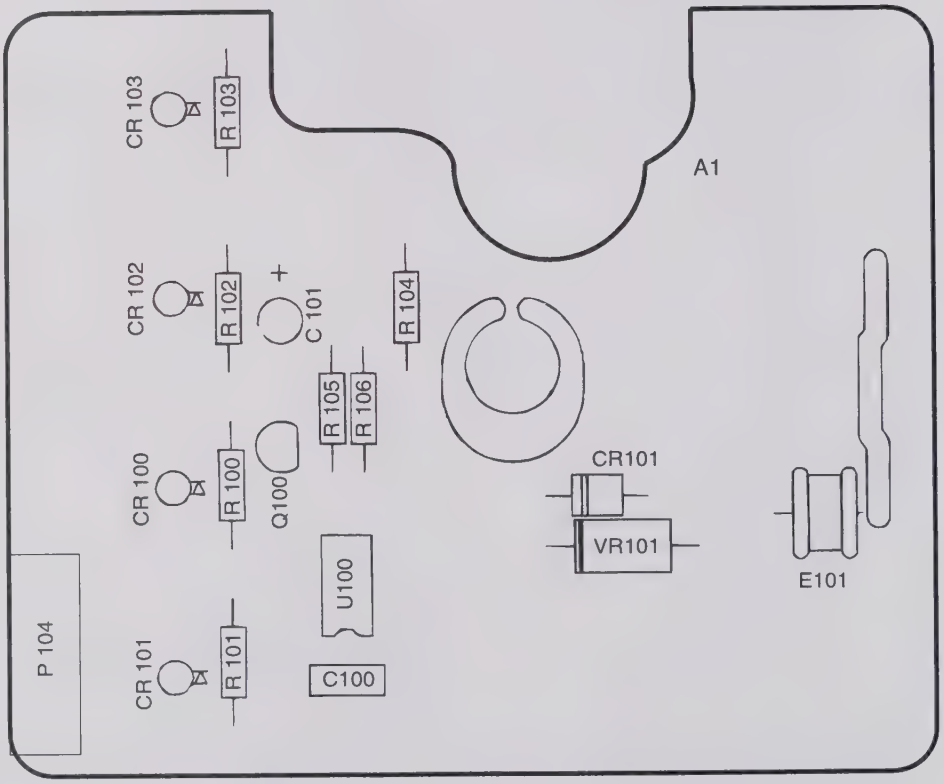


**Figure 6-3. A1 Front Panel PCA**

## Table 6-4. A5 Power Supply PCA

| REFERENCE DESIGNATOR | DESCRIPTION | FLUKE STOCK NO | MFRS SPLY CODE | MANUFACTURERS PART NUMBER OR GENERIC TYPE | TOT QTY | NOTES |
|---|---|---|---|---|---|---|
| C 500,501 | CAP,POLYES,1UF,+-10%,50V | 733089 | 68919 | MKS2-105K50B | 2 | |
| C 502 | CAP,AL,2200UF,+-20%,50V,SOLV PROOF | 876826 | 62643 | KME50T222M18X40LL | 1 | |
| C 503,505,506,<br>C 509,513,517,<br>C 519,520,522,<br>C 523,528,537-<br>C 539 | CAP,POLYES,0.22UF,+-10%,50V | 706028<br>706028<br>706028<br>706028<br>706028 | 68919 | MKS1224K50B | 14 | |
| C 504,514 | CAP,TA,10UF,+-20%,50V | 800516 | 56289 | 199D106X0050FA2 | 2 | |
| C 515 | CAP,TA,10UF,+-20%,35V | 816512 | 56289 | 199D106X0035DG2 | 1 | |
| C 516 | CAP,CER,2200PF,+-10%,500V,Z5R | 817007 | 60705 | 562CRE501EG222KA09 | 1 | |
| C 518,540 | CAP,TA,22UF,+-20%,25V | 845149 | 56298 | 199D226X0025DG2 | 2 | |
| C 524,527 | CAP,TA,6.8UF,+-20%,35V | 807602 | 56289 | 199D685X0035DE2 | 2 | |
| C 525 | CAP,TA,68UF,+-20%,16V | 875422 | 56289 | 199D686X016EE2 | 1 | |
| C 526 | CAP,CER,2000PF,+-5%,50V,C0G | 832618 | 04222 | SR215A202JAA | 1 | |
| C 529,530 | CAP,TA,22UF,+-20%,25V | 845149 | 56289 | 199D226X0025DG2 | 2 | |
| C 531 | CAP,TA,150UF,+-20%,15V | 422576 | 56289 | 199D157X0015FA1 | 1 | |
| C 532,534,535, | CAP,TA,2.2UF,+-10%,35V | 697433 | 56289 | 199D225X9035BG2 | 3 | |
| CR 500 | ϟ THYRISTOR,SI,SCR,VBO=600V,20A | 886978 | 61636 | BT152-600R | 1 | |
| CR 501-510,513-<br>CR 517 | DIODE,SI,100 PIV,1.0 AMP | 742874<br>742874 | 65940 | 1N4002A | 15 | |
| CR 511,512 | ϟ DIODE,SI,BV= 75.0V,IO=150MA,500MW | 698720 | 65940 | 1N4448 | 2 | |
| F 501 | FUSE,8X8.5MM,1.6A,250V,SLOW,RADIAL | 816488 | 0JR59 | 19372-TPRL-1.600 | 1 | |
| J 502 | CONN,D-SUB,PWB,RT ANG,9 SCKT | 886713 | 00779 | 748979-1 | 1 | |
| J 503 | HEADER,2 ROW,.100CTR,RT ANG,10 PIN | 886965 | 00779 | 499141-1 | 1 | |
| J 504 | HEADER,1 ROW,.100CTR,6 PIN | 758003 | 00779 | 641126-6 | 1 | |
| J 505 | HEADER,1 ROW,.156CTR,4 PIN | 385443 | 00779 | 640388-4 | 1 | |
| K 500 | RELAY,ARMATURE,2 FORM C,12VDC | 876974 | 61529 | DS2YE-S-DC12V | 1 | |
| MP 501 | SWITCH ACC,CAP,BLK | 876891 | 09353 | 7089-2 | 1 | |
| MP 554 | CABLE ACCESS,TIE,4.00L,.10W,.75 DIA | 172080 | 06383 | SST-1M | 1 | |
| P 501 | HEADER,1 ROW,.156CTR,3 PIN | 380022 | 00779 | 640388-3 | 1 | |
| Q 502,505-507 | ϟ TRANSISTOR,SI,N-DMOS PWR FET,TO-92 | 782565 | 59640 | VN0104N3 | 4 | |
| Q 503 | ϟ TRANSISTOR,SI,NPN,SMALL SIGNAL,TO-92 | 698225 | 27014 | 2N3904 | 1 | |
| Q 504 | ϟ TRANSISTOR,SI,P-MOS,0.3 OHM,TO-220 | 782516 | 59993 | IRF9531 | 1 | |
| R 500 | RES,MF,200,+-1%,0.125W,100PPM | 832063 | 91637 | CMF-55 2000F T-1 | 1 | |
| R 501 | RES,CC,560,+-5%,1W | 266361 | 01121 | GB5615 | 1 | |
| R 502,503 | RES,MF,10.7,+-1%,0.5W,100PPM | 168740 | 91637 | CMF65 10R7F T-1 | 2 | |
| R 504 | RES,MF,143,+-1%,0.125W,100PPM | 192906 | 91637 | CMF-55 1430F T-1 | 1 | |
| R 505,531 | RES,MF,121,+-1%,0.125W,100PPM | 343160 | 91637 | CMF-55 1210F T-1 | 2 | |
| R 506 | RES,MF,1.54K,+-1%,0.125W,100PPM | 289066 | 91637 | CMF-55 1541F T-1 | 1 | |
| R 514 | RES,MF,13.7K,+-1%,0.125W,100PPM | 719617 | 91637 | CMF55 1372F T-1 | 1 | |
| R 515,544,548 | RES,MF,75K,+-1%,0.125W,100PPM | 291443 | 91637 | CMF-55 7502F T-1 | 3 | |
| R 517,520,549 | RES,MF,20.5K,+-1%,0.125W,100PPM | 261669 | 91637 | CMF-55 2052F T-1 | 3 | |
| R 518 | RES,MF,1M,+-1%,0.125W,100PPM | 719492 | 91637 | CMF-55 1004F T-1 | 1 | |
| R 519 | RES,MF,174K,+-1%,0.125W,100PPM | 235184 | 91637 | CMF55 1743F T-1 | 1 | |
| R 521 | RES,MF,39.2K,+-1%,0.125W,100PPM | 837401 | 91637 | CMF-55 3922F T-1 | 1 | |
| R 529 | RES,MF,5.9K,+-1%,0.125W,100PPM | 267351 | 91637 | CMF-55 5901F T-1 | 1 | |
| R 532 | RES,MF,1.37K,+-1%,0.125W,100PPM | 866256 | 91637 | CMF-55 1371F T-1 | 1 | |
| R 533 | RES,MF,649,+-1%,0.125W,100PPM | 720458 | 91637 | CMF-55 6490F T-1 | 1 | |
| R 534 | RES,MF,1.33K,+-1%,0.125W,100PPM | 260307 | 91637 | CMF55 1331F T-1 | 1 | |
| R 535 | RES,MF,33.2K,+-1%,0.125W,100PPM | 291393 | 91637 | CMF-55 3322F T-1 | 1 | |
| R 536,552 | RES,MF,20K,+-1%,0.125W,100PPM | 719823 | 91637 | CMF-55 2002F T-1 | 2 | |
| R 537 | RES,MF,200K,+-1%,0.125W,100PPM | 719831 | 91637 | CMF-55 2003F T-1 | 1 | |
| R 538 | RES,MF,14.3K,+-1%,0.125W,100PPM | 291617 | 91637 | CMF-55 1432F T-1 | 1 | |
| R 539 | RES,MF,95.3K,+-1%,0.125W,100PPM | 289561 | 91637 | CMF55 9532F T-1 | 1 | |
| R 540 | RES,MF,10.5K,+-1%,0.125W,100PPM | 719500 | 91637 | CMF55 1052F T-1 | 1 | |

## Table 6-4. A5 Power Supply PCA (cont)

| REFERENCE DESIGNATOR | DESCRIPTION | FLUKE STOCK NO | MFRS SPLY CODE | MANUFACTURERS PART NUMBER OR GENERIC TYPE | TOT QTY | NOTES |
|---|---|---|---|---|---|---|
| R 541 | RES,MF,93.1K,+-1%,0.125W,100PPM | 223586 | 91637 | CMF55 9312F T-1 | 1 | |
| R 542 | RES,MF,2.49K,+-1%,0.125W,100PPM | 719930 | 91637 | CMF-55 2491F T-1 | 1 | |
| R 543 | RES,MF,18.7K,+-1%,0.125W,50PPM | 347088 | 91637 | CMF55 1872F T-1 | 1 | |
| R 545 | RES,MF,140K,+-1%,0.125W,100PPM | 289439 | 91637 | CMF55 1403F T-1 | 1 | |
| R 546 | RES,MF,3.16M,+-1%,0.125W,100PPM | 494815 | 91637 | CMF55 3164F T-1 | 1 | |
| R 547 | RES,MF,9.76K,+-1%,0.125W,100PPM | 241489 | 91637 | CMF55 9761F T-1 | 1 | |
| R 550 | RES,MF,69.8K,+-0.1%,0.125W,25PPM | 346825 | 91637 | CMF55 6982F T-1 | 1 | |
| R 551,560 | RES,MF,10K,+-1%,0.125W,100PPM | 719476 | 91637 | CMF-55 1002F T-1 | 2 | |
| R 553 | RES,MF,121K,+-1%,.125W,100PPM | 851225 | 91637 | CMF-55 1213F T-1 | 1 | |
| R 554 | RES,MF,100,+-1%,0.125W,100PPM | 719450 | 91637 | CMF-55 1000F T-1 | 1 | |
| R 558 | RES,CF,4.7K,+-5%,0.25W | 573311 | 59124 | CF1/4 472J | 1 | |
| R 559 | RES,MF,10,+-1%,0.125W,100PPM | 719443 | 91637 | CMF-55 10R0F T-1 | 1 | |
| RT 502,503 | THERMISTOR,DISC,POSITIVE,1,+-20% | 816165 | 54583 | 911X01C010MB13D | 2 | |
| SW 501 | SWITCH,PUSH-BTN,SPDT,MOMENTARY,RT ANG | 743252 | 09353 | E121SD1AGE | 1 | |
| SW 502 | SWITCH,SLIDE,SPDT | 453365 | 79727 | G1-116-0005,G-20-32 | 1 | |
| TP 1, 2,501, TP 502,504,507- TP 509,512,513 | JUMPER,WIRE,NONINSUL,0.200CTR | 816090 816090 816090 | 91984 | 150T1 | 10 | |
| U 500,504 | ϟ IC,VOLT REG,ADJ,POS,LOW DROPOUT | 876537 | 64155 | LT1086CT | 2 | |
| U 501,507 | ϟ IC,COMPARATOR,QUAD,14 PIN DIP | 387233 | 27014 | LM339N | 2 | |
| U 505 | ϟ IC,10.00V,65 PPM TC,VOLTAGE REF | 876532 | 64155 | REF-01CN8 | 1 | |
| U 506 | ϟ IC,OP AMP,MICROPOWER,DUAL,8 PIN DIP | 876495 | 64155 | LT1078-CN8 | 1 | |
| U 509 | ϟ IC,CMOS,QUAD 2 INPUT NAND GATE | 453241 | 04713 | MC14011BCP | 1 | |
| U 511 | ϟ IC,SWITCHED CAP VOLT CONV W/REG,8 DIP | 876800 | 64155 | LT1054CN | 1 | |
| U 513 | ϟ ISOLATOR,OPTO,LED TO DARLINGTON,DUAL | 640664 | 28480 | HCPL-2730 | 1 | |
| VR 501 | ϟ ZENER,UNCOMP,43V,5%,30MA,0.5W | 851584 | 04713 | 1N5260B | 1 | |
| VR 502 | ϟ ZENER,UNCOMP,13.0V,5%,9.5MA,0.4W | 110726 | 04713 | 1N964 | 1 | |
| VR 503 | ϟ ZENER,UNCOMP,15.0V,5%,1.0MA,0.4W | 352377 | 14552 | DZ720825D | 1 | |
| VR 504 | ϟ ZENER,UNCOMP,5.4V,5%,0.03MA,4.0W | 680504 | 15238 | Z7350 | 1 | |
| VR 508 | ϟ ZENER,UNCOMP,20.0V,5%,6.2MA,0.4W | 832576 | 04713 | 1N968B | 1 | |
| VR 509 | ϟ ZENER,UNCOMP,18.0V,5%,7.0MA,0,4W | 327973 | 04713 | 1N9678B | 1 | |
| NOTES: | ϟ Static sensitive part. | | | | | |

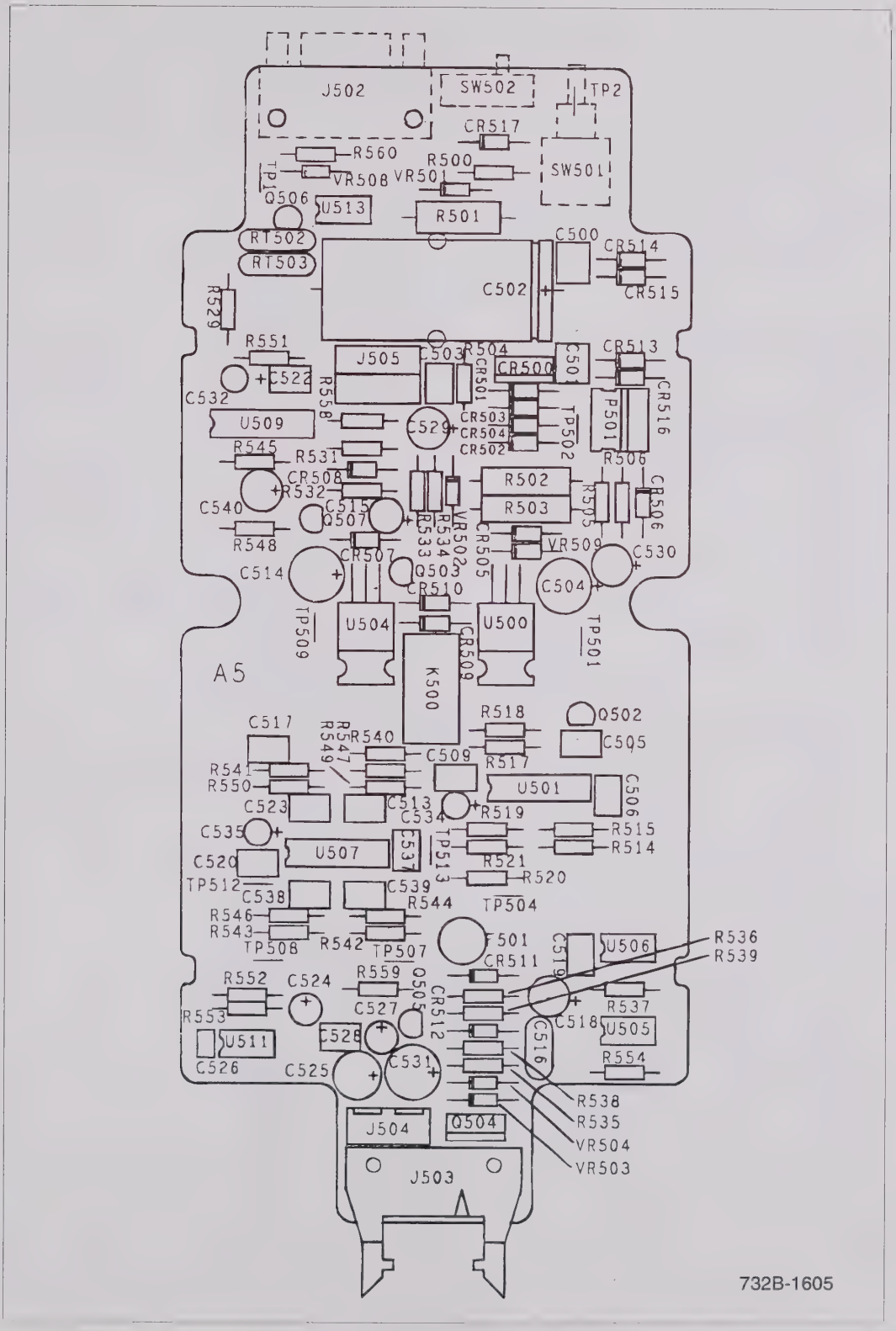


Figure 6-4. A5 Power Supply PCA

## Federal Supply Codes for Manufactures

00779
AMP, Inc.
Harrisburg,PA

01121
Allen-Bradley Co.
Milwaukee, WI

01295
Texas Instruments Inc.
Semiconductor Group
Dallas,TX

04222
AVX Kyocera Corp.
Myrtle Beach, SC

04713
Motorola Inc.
Semiconductor Products Sector
Phoenix, AZ

06383
Panduit Corp.
Tinley Park, IL

06915
Richco Plastic Co.
Chicago, IL

09353
C and K Components Inc.
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# Chapter 7
# Schematic Diagrams

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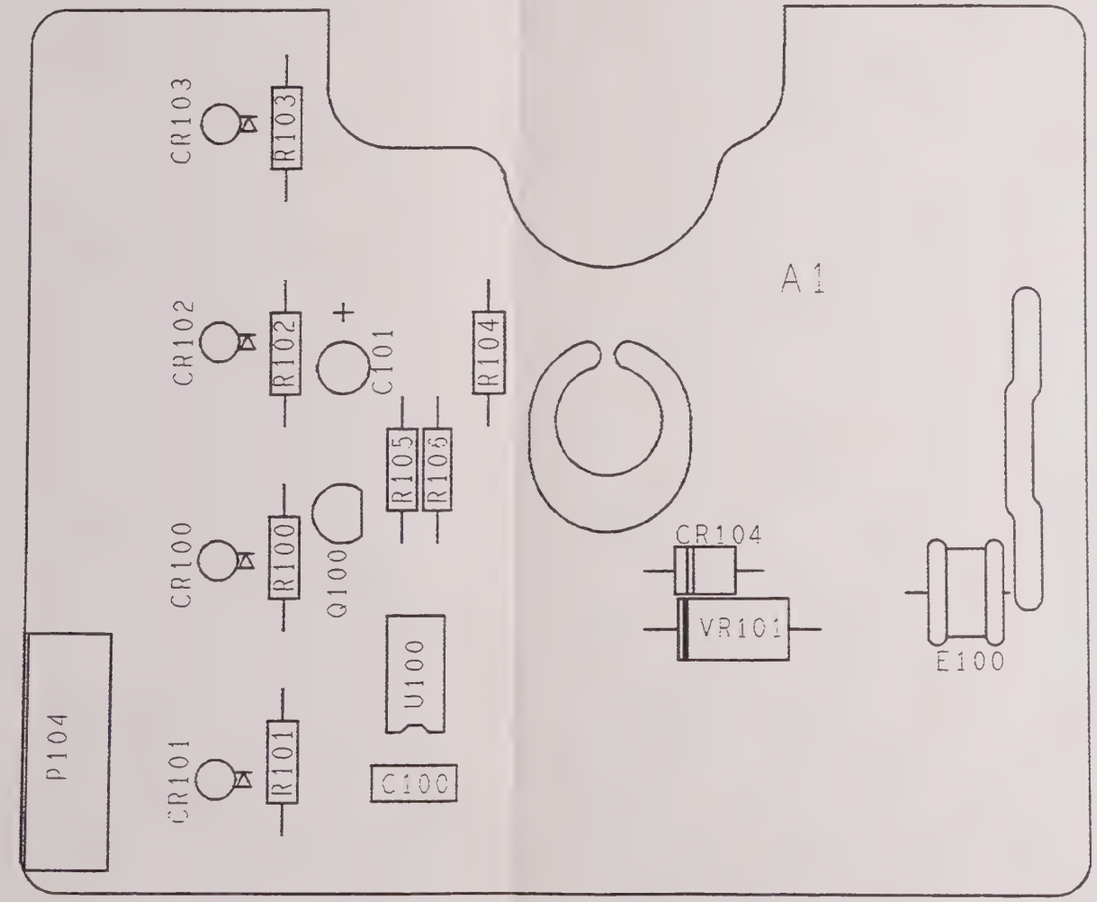



732B-1601

Figure 7-1. Front Panel PCA

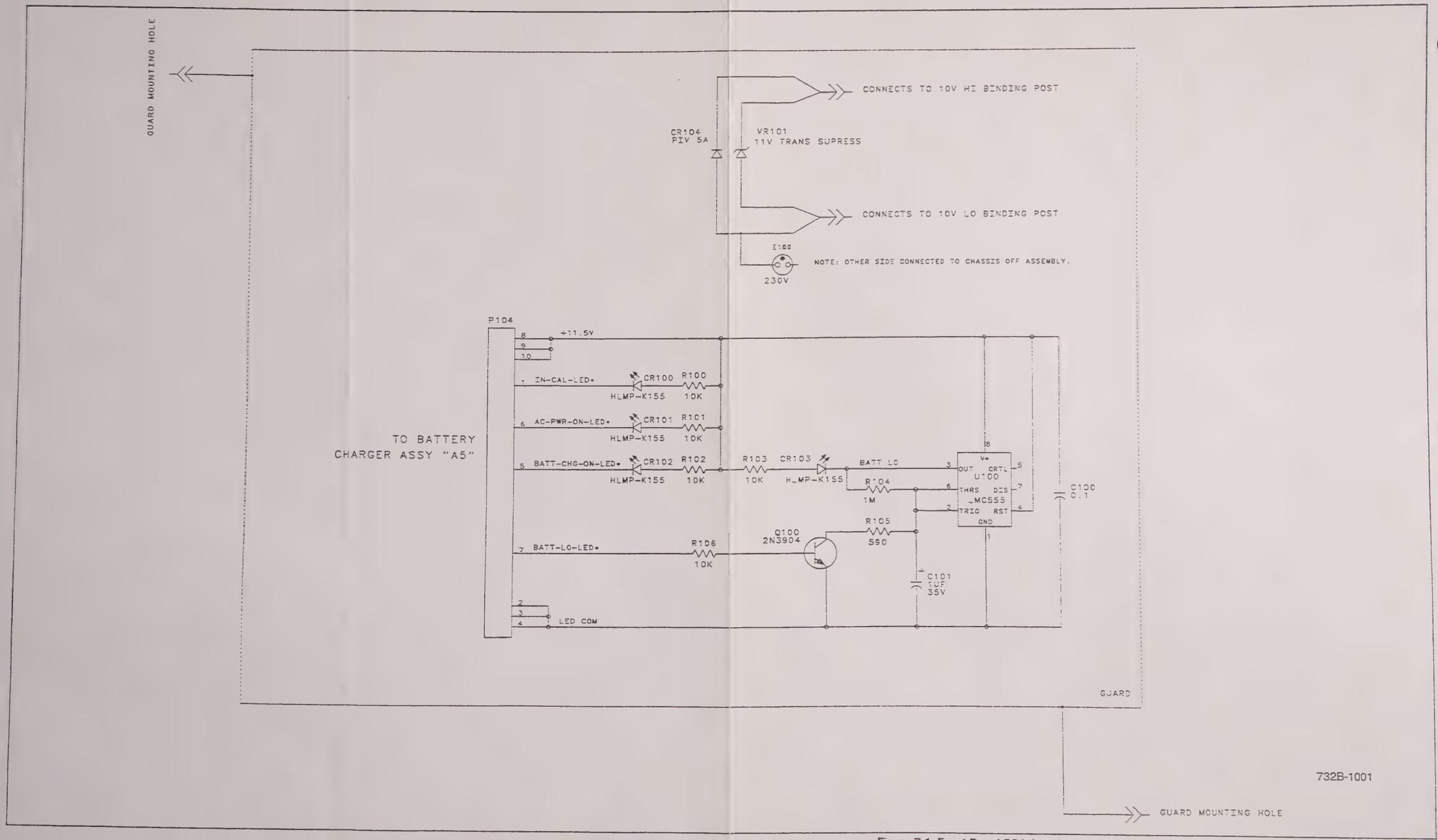



Figure 7-1. Front Panel PCA (cont)

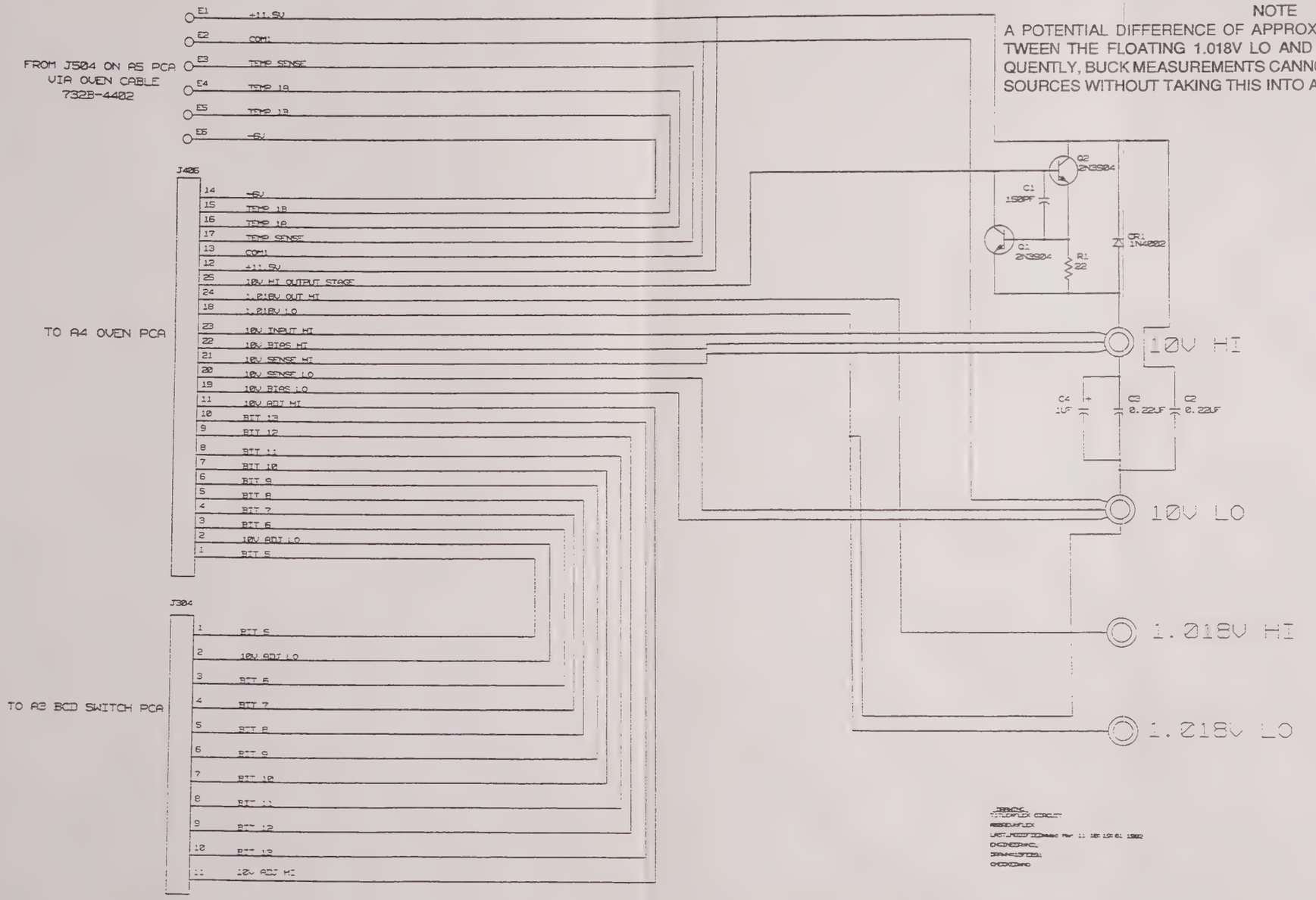

NOTE
A POTENTIAL DIFFERENCE OF APPROXIMATELY < 200 µV EXITS BETWEEN THE FLOATING 1.018V LO AND 10V LO TERMINALS. CONSEQUENTLY, BUCK MEASUREMENTS CANNOT BE MADE BETWEEN THESE SOURCES WITHOUT TAKING THIS INTO ACCOUNT.
FROM J504 ON A5 PCA VIA OVEN CABLE 732B-4402
TO A4 OVEN PCA
TO A3 BCD SWITCH PCA
J406
J304
10V HI
10V LO
1.018V HI
1.018V LO
732B-1002

Figure 7-2. A2 Flex Circuit PCA

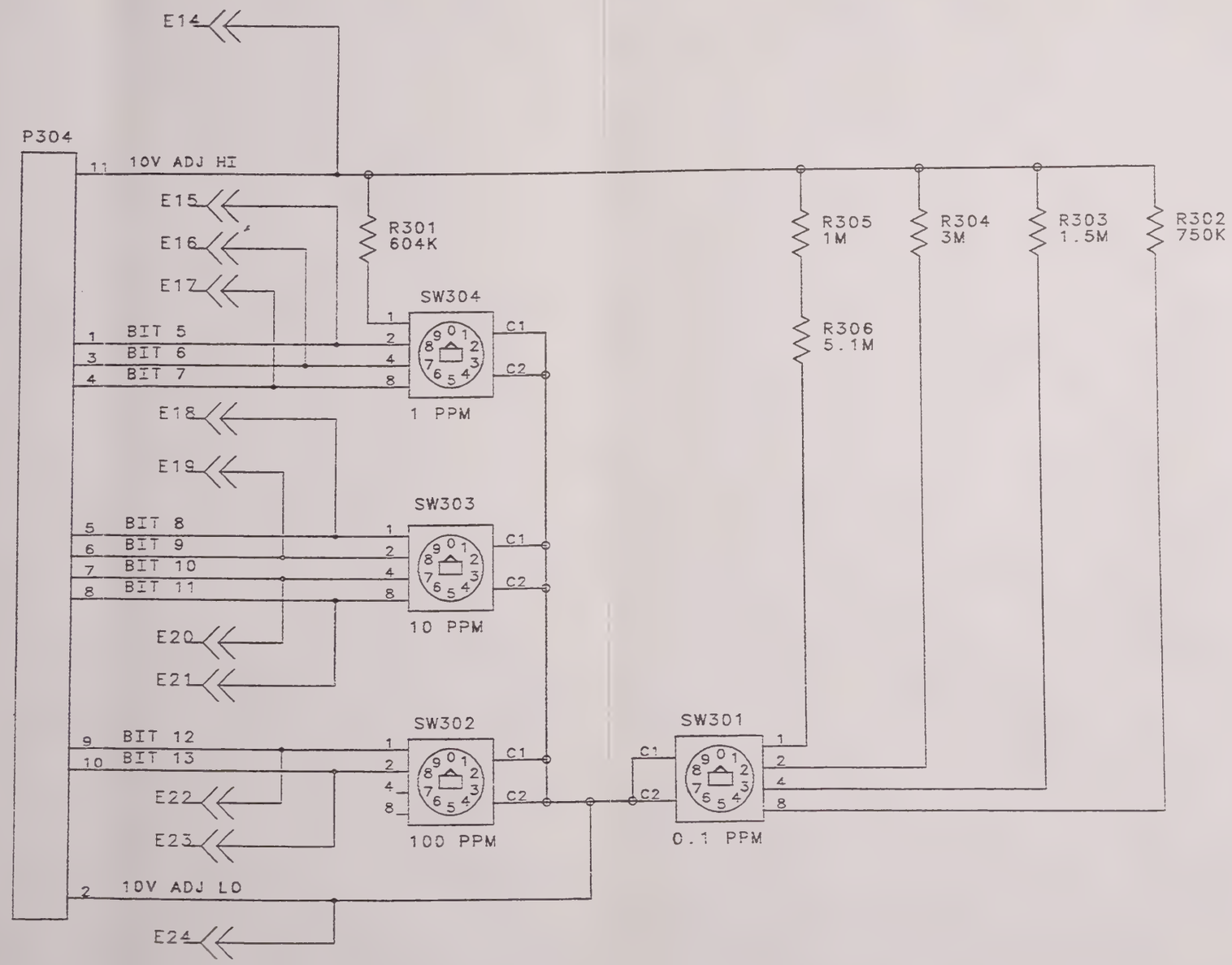
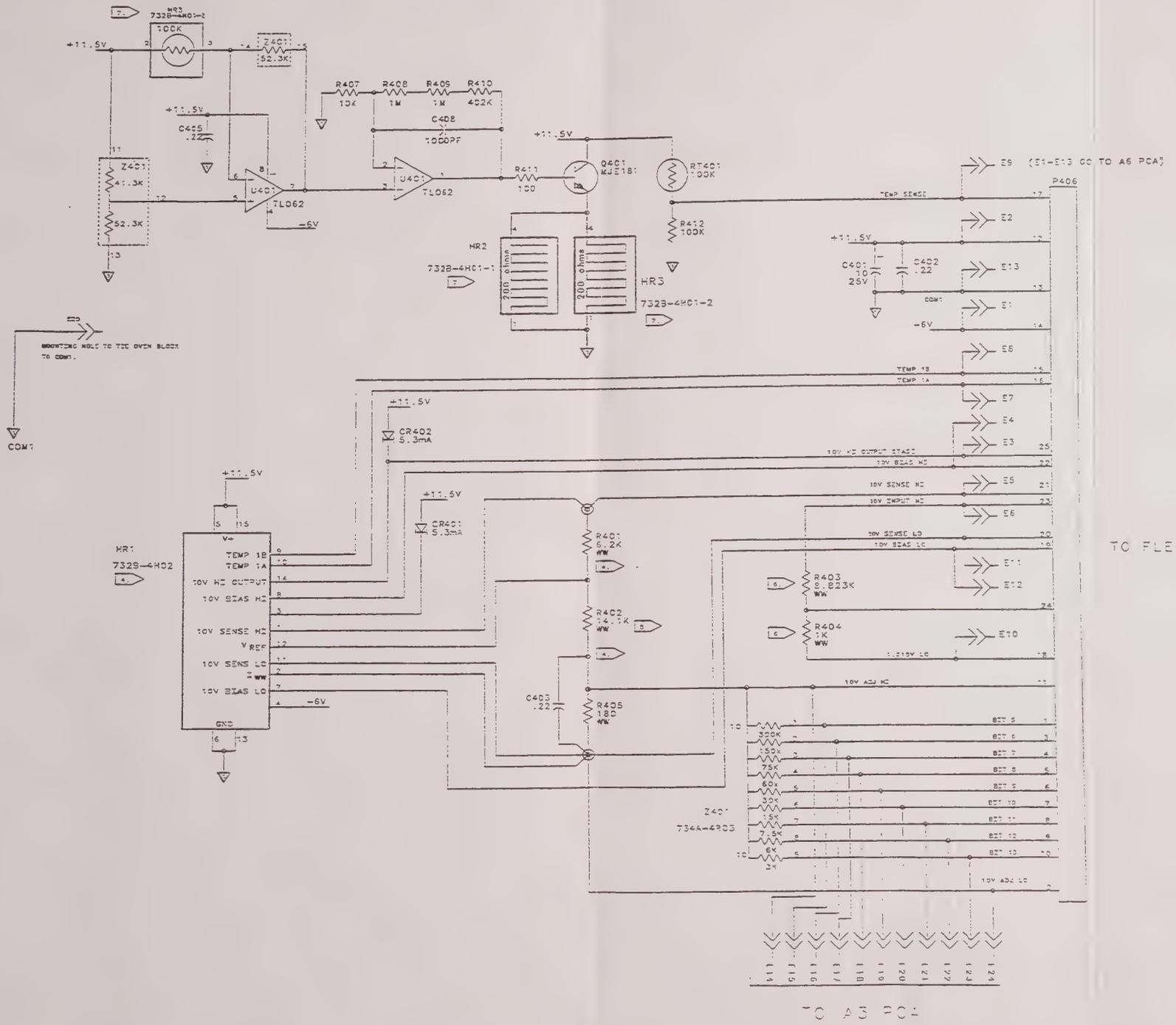
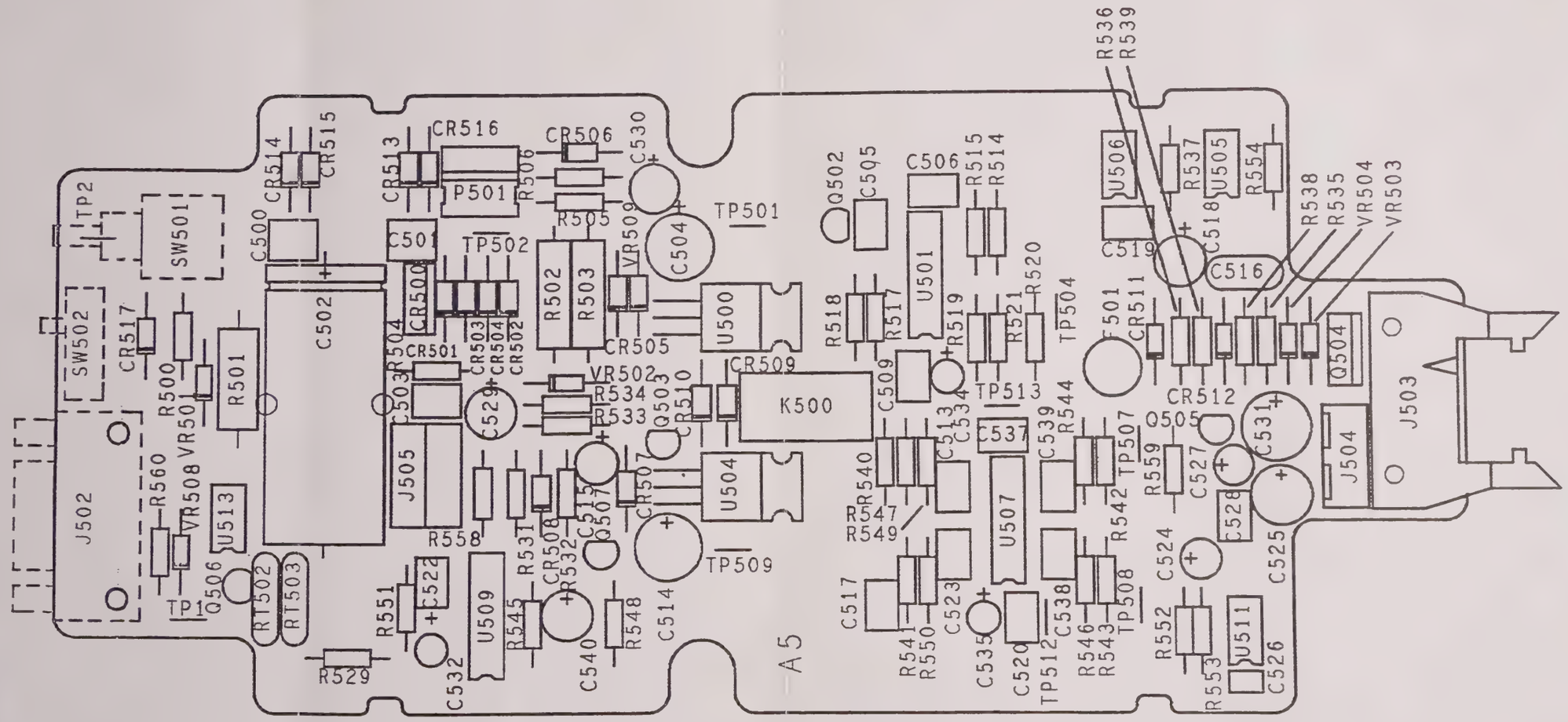



Figure 7-3. A3 BCD Switch PCA




732B-1004

Figure 7-4. A4 Oven Control PCA




732B-1605

Figure 7-5. A5 Power Supply PCA

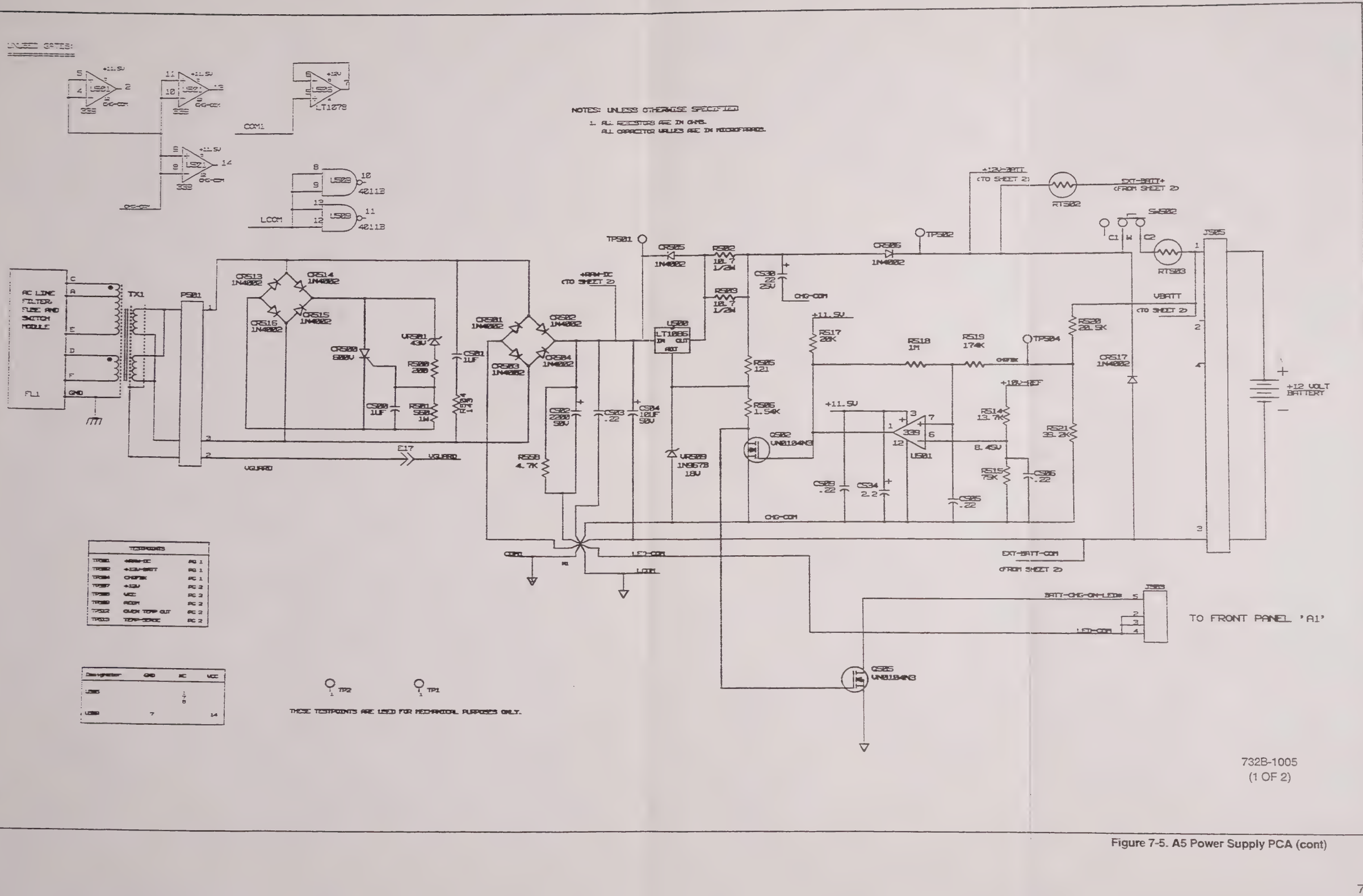
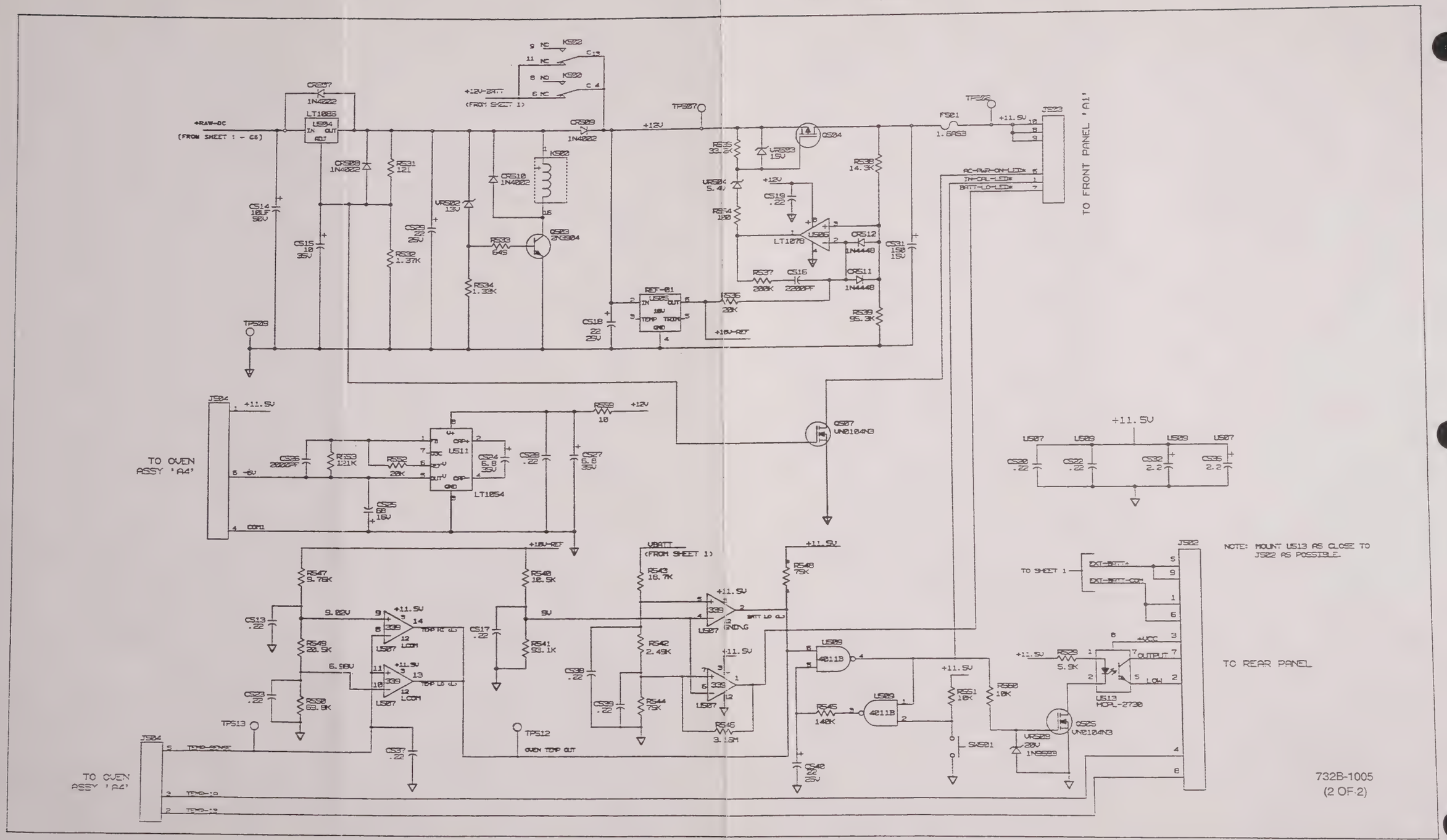



Figure 7-5. A5 Power Supply PCA (cont)

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